THE

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THE SCIENTIFIC IMAGINATION.

EVEN for the trained investigator it appears to be almost impossible to take up the position of suspended judgment. The untutored mind, we know, must always come to some conclusion, and form some theory, with the most meagre data. Perhaps it is a conscious or unconscious desire on the part of scientists to satisfy this popular craving for definite views on the most abstruse and imperfectly understood phenomena of nature, that has given birth in recent years to so much crude and ephemeral speculation on scientific questions. These speculations are taken by the popular mind as facts, they will probably mislead the humbler workers in the field, and they will certainly throw a certain amount of discredit on science, when disproved. We do not by this mean to undervalue the use of the working hypothesis, which, however, should be kept by the investigator as a temporary guide, ready to be discarded when disproved.

No branch of science has suffered more than electricity from the lack of the virtue of suspending judgment. Not to mention the bran-new electrician who, perhaps, with a judgment already matured, has acquired a smattering of electrical knowledge at Finsbury or the Central Institute, and is prepared forthwith to explain, what electricity is; we find men of standing in the electrical world condescending to form theories where the known facts are so few, that the probabilities are immensely against the theories being supported by fresh evidence.

The lecture on Cosmical Electricity, delivered recently by Prof. Elihu Thomson before the Franklin Institute, cannot be altogether acquitted from this charge of crude theorising. He is reported to have said "that the results of recent investigations have shown that an excellent vacuum is not a conductor, but the most perfect insulator. That, taking this in connection with the fact that dense air is a good insulator, that rarefied gas is a fair conductor, and that the solid body of the earth is a conductor, he compared the earth to a huge condenser possessing a positive charge in the outer layers, while the earth itself might be less positive or negative. Using the results of Prof. Rowland's works on the movement of a charged body giving rise to magnetism and the principle of an air condenser, he put forward the idea that the earth being a huge rotating condenser, with the positive charge in the upper layers of the atmosphere and the negative charge at the ground, it would necessarily follow that magnetism could be developed in the region between this upper layer and the earth by the rotation of these charges."

This may be magnificent, but it is not science. It is true that with a cloudless sky the electrical condition of the atmosphere is generally, though not invariably, positive with respect to the earth. On the eve of thunderstorms, however, the clouds are more strongly electrified, sometimes positively and sometimes negatively. If the earth's magnetism were due to the movement of its electrostatic field, we should

expect during thunderstorms the most violent local disturbances, amounting, even, to reversals of terrestrial magnetism. This we know is not the case; nor is there any evidence that the upper rarefied layers of the atmosphere, though fair conductors, are capable of carrying an electric discharge. Heydweiller, in fact, found that it was impossible to communicate electrification to air either by the brush or the glow discharge.

Prof. Thomson also in the course of his lecture "mentioned that the idea had come to him that possibly thunderstorms were in a measure due to flaws in the dense air as a dielectric, and explained in detail somewhat his thoughts on this subject. He drew attention to the consequences which would follow the possession by a mass of nebulous gas of a charge of electricity; this, if insulated in space, would, as its volume diminished by the radiation of heat and condensation, gradually increase in potential, however small the charge originally possessed." If we once were convinced that the upper rarefied layers of the atmosphere formed the higher charged outer coating of a huge terrestrial Leyden jar, it would be a very plausible theory that lightning discharges might be due to the weakening of the dielectric at certain points by the rise of columns of moist and hot air. But every such thunderstorm must lead to an equalisation of potential between the earth and the upper layers of the atmosphere, and consequently the earth's electrostatic field, and with it the earth's magnetism, must long since have disappeared. Perhaps Prof. Thomson has discovered some *vera causa* to explain the replenishing of the outer coating of the terrestrial jar; but we confess that, at present, we can imagine none. As to the effect on a nebulous mass of a charge of electricity, it appears to us that the result would not be a rise of potential, but a dispersal of its particles by mutual repulsion, and a consequent fall of potential. Of course, when the nebulous body had condensed to the liquid condition, and the forces of cohesion had come into play, any further condensation would lead to an increase of the potential of the charge by the reduction of capacity.

Another of Prof. Thomson's ideas is that the condensation of the solar mass leads to a rise of electric potential on its surface, and may account for the expulsion of the coronal stream, the electrical charged material of which might be encountered by the earth in its movement round the sun, and so give rise to auroral display. This is ingenious, but we think it far more probable that the auroral display consists of discharges in the upper rarefied layers of the atmosphere, due to changes in the magnetic field through which the earth is passing. Prof. J. J. Thomson has recently shown that these auroral discharges in the upper regions of the atmosphere may play a very important part in preventing terrestrial magnetic disturbances. If the part of the solar system traversed by the earth were a magnetic field, the discharges in the rarefied upper air would screen off from the earth all magnetic effects which were not symmetrical about the axis of rotation.

Finally, Prof. Thomson suggests that temporary stars might be explained on an electrical hypothesis, viz., that charged bodies possessing a difference of electrical potential when they approach near enough, might exchange electricity between themselves on the grandest scale, giving rise to a uniformity of charge on their leaving each other; that this would naturally be done in a vast display, which would only last for a moment of time.

In all these theories the *vera causa* is wanting. There is no reason at present known for supposing that stars are charged with different kinds of electricity; they belong to the class of unverifiable hypotheses, and to the even-minded astronomer, must savour of the bias of the electrician who wants to explain everything by electricity.

JOURNALISM AND LIBELS.

The law of libel occasionally weighs heavily upon journalism. No honest journalist desires to evade the responsibility of his uttered opinions; still, if his language is to be clear, emphatic, and reliable, he must be protected against unscrupulous litigants.

This view of the matter may be considered as far-fetched as protecting counsel against witnesses. Few of the general public, however, know how a newspaper may be harassed by a person who has had the privilege of being mentioned in its pages. It is a popular notion that the greater the truth the greater the libel; but the least disparaging remark may bring a writ for libel. It does not follow that a verdict will be given against the paper, but the trouble of defending the safest case is enormous, and to this may be occasionally added the inability of the plaintiff to pay costs. We are not going to advocate an unregulated press, for we are conscious of the scurrility that might result, but some modification of the law is urgently needed. At the present moment a plaintiff is not bound to give security for costs, which is manifestly unjust to a newspaper proprietor. It would be obviously unfair if poverty were to preclude a libelled person from seeking redress, but newspapers do not seek protection against persons who have really suffered, but against the man of straw, anxious to make money out of a fancied insult or a really justifiable criticism.

If a judge had discretionary powers, this person of no substance might be prevented bringing needless and foolish actions. The present law permits anybody who thinks he has been libelled to commence an action. There may not be the remotest chance of recovering damages, and the plaintiff's claim may be most paltry, yet the defendant must be as fully equipped to meet trumpery charges as would be necessary to meet really genuine claims.

Alternator Curves.

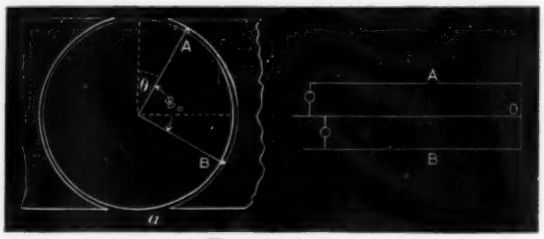
The fact that the curves of electromotive force due to each pair of poles in an alternator may be considerably dissimilar from one another, is probably well known to all designers, but we do not know of any complete set of curves being published other than those laid before the American Association for the Advancement of Science by Mr. Bedell and his colleagues. These curves show (like those of previous experimenters in this line), that the successive waves of E.M.F. due to successive poles, vary both in general shape and also in area. In ordinary cases, where the whole of the armature coils are in series, this would not be a matter worth considering, but in those types of machine which have the two halves of the armature put in parallel, it is conceivable that losses might occur, due to local currents following the differences in E.M.F. here found to exist.

RELATIVE COSTS OF DISTRIBUTION BY DIFFERENT ELECTRICAL SYSTEMS WITH THE SAME EFFECTIVE OR MAXIMUM E.M.F.*

BY W. D. WEAVER.

THE saving in copper over the simple alternating system in the two and three-phase systems still being a matter of dispute, the following is offered as an attempt, starting from first principles in each case, to determine if the problem, if it so may be called, does not admit of a perfectly definite solution. In the first part of the article, the comparisons will be made on the basis of effective E.M.F., and in the second part on the basis of insulation stress or maximum E.M.F. Mr. Gisbert Kapp, in an able paper read before the last meeting of the British Association for the Advancement of Science, brought forward, for the first time it seems, the latter method of comparison, but without giving any clue to the manner in which he arrived at the results stated.

Fig. 1 represents diagrammatically a two-phased generator, A and B being sections of the armature wires, the other extremities of which are joined and led to a third collecting



FIGS. 1 AND 2.

ring. Fig. 2 represents a two-phased system developed, the heavy lines designating the armature wires or the seat of the E.M.F. To simplify matters, we will assume the junction of the two armature wires to be maintained at zero potential.

Then, the rate at which A and B are cutting lines of force are $\sin\theta$ and $\sin(\theta + 90^\circ)$ respectively, or the E.M.F. at any instant between A and O, B and O, and A and B is $\sin\theta$, $\cos\theta$ and $(\sin\theta + \cos\theta)$ respectively, neglecting constants, while the effective E.M.Fs. are

$$\left(\frac{1}{2\pi}\int_0^{2\pi}\sin^2\theta\,d\theta\right)^{\frac{1}{2}},\quad \left(\frac{1}{2\pi}\int_0^{2\pi}\cos^2\theta\,d\theta\right)^{\frac{1}{2}} \text{ and}$$

$$\left(\frac{1}{2\pi}\int_0^{2\pi}(\sin\theta+\cos\theta)^2\right)^{\frac{1}{2}} \qquad (1)$$

or $\frac{\sqrt{2}}{2}$, $\frac{\sqrt{2}}{2}$ and 1; that is, the E.M.F. between the extreme wires is $\sqrt{2}$ times greater than that between either leading wire and what may be called the common return.

Assuming that the entire resistance in each of the two circuits is unity, the currents flowing at the same instant in the three wires (fig. 2) have the values $\sin\theta$, $\cos\theta$, and $(\sin\theta + \cos\theta)$ and the effective currents are, therefore, also respectively $\frac{\sqrt{2}}{2}$, $\frac{\sqrt{2}}{2}$ and 1; that is, the current in the common wire is $\sqrt{2}$ times greater than the current in either of the other two wires.

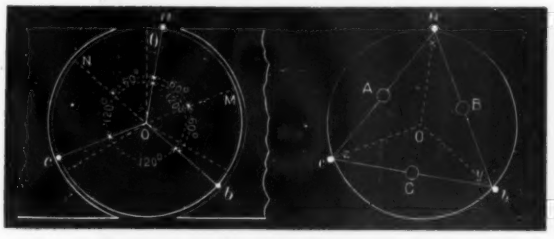
Fig. 3 represents diagrammatically a three-phased generator with a "star" winding, *a*, *b*, and *c*, being sections of the armature wires, which are supposed to be joined at the other end of the armature. Assuming that the point of union is maintained at zero potential, then the rate at which each wire is cutting lines of force, and therefore the potential at the end of each wire on open circuit, is, at $a = \sin\theta$; at $b = \sin(120^\circ + \theta) = \sin(60^\circ - \theta)$; at $c = \sin(240^\circ + \theta) = -\sin(60^\circ + \theta)$, from which it follows that the poles of a three-phased motor differ by 60° in phase. This might have been foreseen, for by drawing the lines O M and O N, it is evident that wires at M and N would cut lines of force at the same rate as the wires *c* and *b*.

* We are indebted to the *Electrical World* (N.Y.), for advance sheets of this paper.—EDS. ELEC. REV.

Connecting the points, *a*, *b* and *c* (fig. 4), the difference of potential at any instant between *a*-*b*, *b*-*a* and *b*-*c* are respectively

$$\text{A} = \sin\theta + \sin(60^\circ+\theta);\ \text{B} = \sin(60^\circ-\theta) - \sin\theta;$$
$$\text{C} = \sin(60^\circ-\theta) + \sin(60^\circ+\theta) \qquad (3)$$

from which it follows that the sum of the three E.M.Fs. at any instant is zero, and that the sum of two E.M.Fs. is always equal to the third.



FIGS. 3 AND 4.

The effective E.M.Fs. are:—

$$\text{A}_{eff} = \left(\frac{1}{2\pi}\int_0^{2\pi}\left((\sin\theta+\sin(60^\circ+\theta)\right)^2 d\theta\right) = \sqrt{\frac{3}{2}} \qquad (4)$$

$$\text{B}_{eff} = \left(\frac{1}{2\pi}\int_0^{2\pi}\left((\sin(60^\circ-\theta)-\sin\theta)\right)^2 d\theta\right)^{\frac{1}{2}} = \sqrt{\frac{3}{2}} \qquad (5)$$

$$\text{C}_{eff} = \left(\frac{1}{2\pi}\int_0^{2\pi}\left((\sin(60^\circ-\theta)+\sin(60+\theta))\right)^2 d\theta\right)^{\frac{1}{2}} = \sqrt{\frac{3}{2}} \qquad (6)$$

As the E.M.F. generated in any one winding, as in *a*, is

$$\frac{1}{2\pi}\int_0^{2\pi}\sin^2\theta\,d\theta = \frac{\sqrt{2}}{2} \qquad (7)$$

if to the windings of a 1,000-volt alternator two similar windings are added and so arranged to develop three-phased currents, the E.M.F. will be raised $\sqrt{\frac{3}{2}} \Big/ \frac{\sqrt{2}}{2} = \sqrt{3}$ times, or to 1,732 volts, instead of 3 times, or to 3,000 volts if the additional windings were superimposed on the original ones. Or, if the armatures of three 1,000-volt alternators are rigidly coupled with corresponding coils advanced with relation to each other one-third of the distance between poles, three-phased currents will be generated with E.M.Fs. of 1,732 volts. It will also be seen, referring to figs. 3 and 4, that if the point where the three wires are joined is united to a fourth collecting ring, the difference of potential between the fourth wire and any one of the other three will be $(\sin\theta - 0)$, $\sin(120^\circ + \theta - 0)$, &c., or the effective E.M.F. will be $\sqrt{\frac{1}{2}}$ instead of $\sqrt{\frac{3}{2}}$; that is a three-phased generator may have six circuits with four conductors, three with an E.M.F. of say 1,000 volts, and three with an E.M.F. of 1,732 volts in that case.

Suppose, now, that the currents flowing in the windings *a*, *b*, and *c*, or, which is the same thing, in the three wires of the line, are *x*, *y* and *z*, and that the resistance in each branch, A, B and C (fig. 4), is unity; then, if the currents in the branches at any instant are A, B and C, those in the three legs of the line will be, from (3)

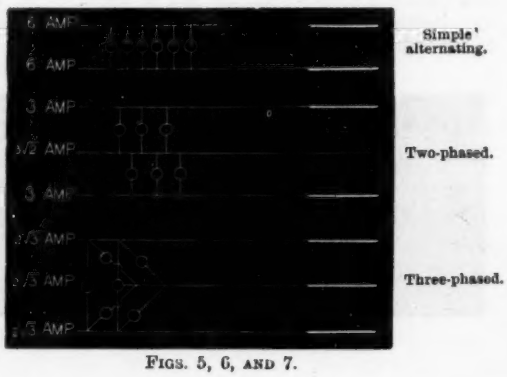
$$x = \text{A} - \text{B} = 3\sin\theta \qquad (8)$$

$$y = \text{B} + \text{C} = \frac{3\sqrt{3}\cos\theta}{2} - \frac{3\sin\theta}{2} \qquad (9)$$

$$z = \text{A} + \text{C} = \frac{3\sqrt{3}\cos\theta}{2} + \frac{3\sin\theta}{2} \qquad (10)$$

Integrating for the effective currents we find these to be $\frac{3}{\sqrt{2}}$ in each case. But since the resistance in the branches is unity, the currents there are $\sqrt{\frac{3}{2}}$, and, therefore, the current in each leg is $\frac{3}{\sqrt{2}} \Big/ \sqrt{\frac{3}{2}} = \sqrt{3}$ times greater.

We can now make a comparison on the basis of effective E.M.Fs. required in distribution for the same C^2 R loss. Suppose the voltage to be the same in each case, that each lamp takes one ampère and that the resistance of each lead is one-ohm. Figs. 5, 6, and 7 represent simple alternating, two and three-phased circuits, each having six lamps of the



FIGS. 5, 6, AND 7.

same voltage, the currents flowing in each lead being as deduced above. The loss

in fig. 5, is $(6)^2 \times 2 = 72$ watts;

in fig. 6, $(3)^2 \times 1 + (3\sqrt{2})^2 \times 1 + (3)^2 \times 1 = 36$ watts;

in fig. 7, $(2\sqrt{3})^2 \times 1 + (2\sqrt{3})^2 \times 1 + (2\sqrt{3})^2 \times 1 = 36$ watts.

Now, if in fig. 5 we were to add another wire of one ohm resistance to each side, the C^2 R loss would be halved, or become 36, the same as in the other cases, and we have the following comparison:

	Work.	C R loss.	Wires.	Saving.
Simple alternating...	6 lamps	36 watts	4	
Two-phased... ...	6 „	36 „	3	25 per cent.
Three-phased ...	6 „	36 „	3	25 „

or, on a basis of effective E.M.Fs., with the two and three-phased systems there is a saving in copper for conductors of 25 per cent. over the simple alternating system in each case, but no saving in the three-phased system over the two-phased.

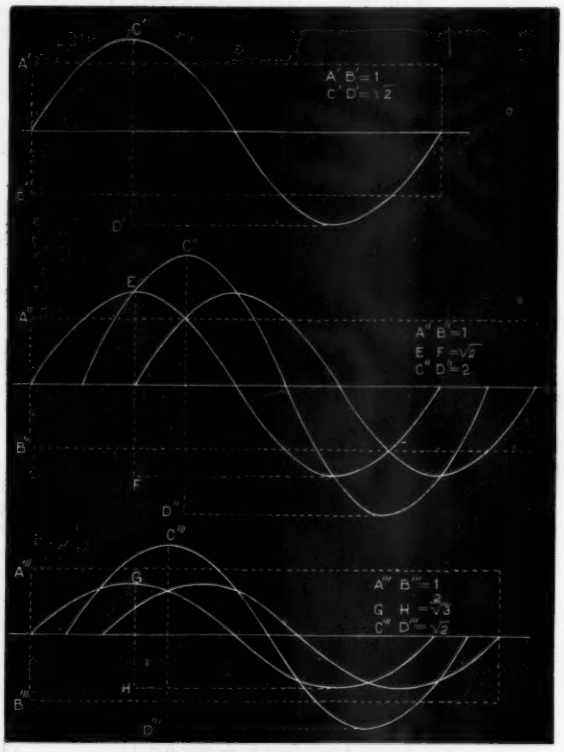
With alternating systems, however, the stress to which insulation is subjected is not a function of the effective, but of the maximum E.M.F.

From (7) we see that in the simple alternating system, if the maximum E.M.F. is unity, the effective E.M.F. is $\frac{\sqrt{2}}{2}$, from which it follows conversely that if the effective E.M.F. is unity the maximum is $\sqrt{2}$.

Similarly, in a two-phased system what may be called the working maximum E.M.F. is also $\sqrt{2}$ when the effective E.M.F. is unity, but from (1) we see that the difference of potential between the two outside leads is $1 \Big/ \frac{\sqrt{2}}{2} = \sqrt{2}$ times this, or the maximum stress in this system for an effective E.M.F. equal to unity is $\sqrt{2} \times \sqrt{2} = 2$.

In the preceding calculations for the three-phased system, we assumed the maximum E.M.F. in any one of the armature wires to be unity, but as the E.M.F. between the working leads was shown to be $\sqrt{3}$ times this, the maximum E.M.F. of the system is $\sqrt{3}$, which corresponds to the effective E.M.F. of $\sqrt{\frac{3}{2}}$ calculated; therefore, reduced to an effective E.M.F. of unity the maximum E.M.F. is $\sqrt{3} \Big/ \sqrt{\frac{3}{2}} = \sqrt{2}$. In figs. 8, 9, and 10 curves are plotted showing the relation between the various E.M.Fs., in which A B in each case represents the effective E.M.F., or that of the direct current used for comparison.

For an effective voltage, therefore, of unity in the simple alternating, two and three-phased systems, the stresses on insulation are as $\sqrt{2}$, 2 and $\sqrt{2}$ respectively, or that much greater than for a direct current of the same voltage, and it follows that if the stress is to be the same as with the direct current, the effective voltage must be reduced in proportion to $\frac{1}{\sqrt{2}}$, 2 and $\frac{2}{\sqrt{2}}$ respectively. If, now, the machines are to do the same work, the currents will have to be increased in the same proportion as the voltages are reduced, and, consequently, the C^2 R losses will become $(1)^2$, $(\sqrt{2})^2$, $(2)^2$ and $(\sqrt{2})^2$ for the direct, simple alternating, two and three-phased systems respectively, or as $1 : 2 : 4 : 2$. But we have shown that for an equal output there is an intrinsic saving of copper of 25 per cent. in the two and three-phased systems over the simple alternating system, and, therefore, also over the direct current system, so that the ratio become $1 : 2 : 3 : 1{\cdot}5$, or as $100 : 200 : 300 : 150$.



FIGS. 8, 9, AND 10.

That is, for the same stress on the insulation, and for the same output in watts, for each 100 pounds of copper required for distribution with direct currents, 200 pounds will be required with simple alternating currents, 300 pounds with two-phased currents, and 150 pounds with three-phased currents. These numbers are the same as those given by Kapp, except that for the two-phased system, which in his paper is 290 instead of 300, as here deduced.

Our contemporary discussing the matter editorially, says: "In another column a mathematical discussion of the relative cost of copper for distribution in different electrical systems arrives at conclusions which at first sight may appear singular in some respects. It is shown that if a basis of effective E.M.F. is taken for comparison, the three-phased alternating system requires the same amount of copper as the two-phased system, while there is a saving of 25 per cent. in each of these over the simple alternating system, which is itself in this respect on a parity with the direct current. If, however, the basis of comparison is the stress on the insulation, or, in other words, the maximum E.M.F. in each case, then the direct current requires the least amount of copper to distribute a given amount of energy at a given loss. The three-phased system comes next in economy, but requires 50 per cent. more copper than the direct current system, while simple alternating currents require 100 per cent., and two-phased currents no less than 200 per cent., more copper for conductors under the same conditions as to energy transmitted, and C^2 R loss. By reference to the curves in the article it

will be seen that the saving noted under the first method of comparison is due to the working currents in the two and three-phased systems overlapping in one conductor, thus giving a resultant current in each case, which is less than what the sum of two currents would be if there was no difference in phase. In the two-phased system the reduction in the resultant current is greater than in the three-phased system, the difference in phase being 90 degrees instead of 60 degrees, but the saving thus implied over the former is balanced by the less favourable working disposition of the E.M.F. in the latter system. If the maximum effective E.M.F. in the two-phased system were also the working E.M.F., as in the three-phased system, then the former would show the greater economy. By reference again to the curves shown it is at once apparent why the direct current is the most favourable as regards the insulation stress or maximum E.M.F., since its effective E.M.F. is also the maximum E.M.F., while in the other three systems this is far from being the case. Here, too, the two-phased system loses in economy for the same reason as given above. That is, if the effective working E.M.F. in each case is 1,000 volts, in the three-phased system this corresponds to the curve of greatest or resultant E.M.F. whose maximum ordinate is 4,411 volts, while in the two-phased system, the corresponding E.M.F., whose maximum ordinate is also 1,414 volts, is that between the two extreme conductors, while the working E.M.F. is that corresponding to the component or primary E.M.F. in relation to which the maximum ordinate is 2,000 volts. While, therefore, by this method of comparison the direct current has the advantage over the alternating current, whether simple or multiphased, and three-phased over two-phased currents, this does not imply much until we approach the limits of insulation stress, whether in conductors or in apparatus, which, it may be added, are scarcely in sight yet. Up to recently our ideas in regard to the consequences of higher voltages were based upon experience with direct currents, in which the considerations were danger to life, and difficulty with commutators, rather than with simple insulation. Owing, however, to the use of transformers with alternating currents, which enables us to almost entirely obviate danger to life from high voltages, the voltage of 16,000 used at the Frankfort-Lauffen transmission was less dangerous in this respect than any arc-light currents, under usual conditions. On account of the absence of commutators, the voltage of 16,000 was also produced with less practical difficulties than one-fourth as great a voltage would be in a direct current machine. The only factor therefore to be ordinarily considered in relation to the voltage of simple or multiphase alternating currents, is the insulation of the line and apparatus, and this factor does not become of direct importance until we approach a practical limit, which seems to be yet far removed. With direct currents, however, we have the two additional factors of danger to life on account of the necessary disposition of the generating and receiving apparatus, and difficulty with commutators, to which may be added a third factor due to electrical difficulties with high voltages at the receiving apparatus, which do not exist where alternating currents are employed with transformers as intermediaries. This is but another illustration of the variance in ideas derived from experience with direct currents and those connected with alternating currents."

DISTURBANCES IN DYNAMOS.*

By J. A. MONTPELLIER.

The disturbances affecting the regular working of an electrical installation arise either in the generating dynamo, the mains, the apparatus used, or, lastly, in the motive power or the mechanical apparatus. This article will only deal with the disturbances proceeding from the generating dynamo.

The investigation of the causes of the disturbances that may arise in a dynamo, while at work, is a delicate operation which can only be brought to a successful conclusion if proceeded with methodically. It is almost impossible to foresee all the special cases that may occur, for we should have to take into account the conditions of working peculiar to each installation. Nevertheless, in most cases, a careful examination of the various parts of the dynamo and systematic tests, will enable us to localise and quickly repair any disturbances that may arise.

The slightest negligence, a badly connected wire, or a loose screw for instance, may cause disturbances, or even a serious accident. Other causes, equally simple, but less easy to discover, may paralyse the working of a whole installation. As a rule, it is sufficient that the mechanic in charge of the dynamos should possess some elementary knowledge to enable him, with the help of a series of clear and precise rules, to remedy at once most of the irregularities that may arise.

The establishment of rules, indicating the plan to be followed in order to find the causes of a disturbance, is not a very difficult matter, when we consider the small number of parts comprising a dynamo, and also its simplicity from a mechanical point of view.

Generally speaking, whenever a disturbance arises, we should immediately proceed to examine minutely the various working parts of the dynamo; in the majority of cases, this examination is sufficient to show the cause of the disturbance. We need not dwell on the importance, in order to avoid accidents, of keeping the dynamo in good repair, of seeing that the lubricators are replenished, that the dynamo is not overloaded, &c.

2. The various irregularities that may affect a dynamo are as follows:—

I. The dynamo gives no current.

II. Large sparks are produced at the brushes.

III. Certain parts of the dynamo are abnormally heated.

IV. The dynamo makes a loud noise or vibrates excessively while it is working.

V. The armature does not turn at its normal speed.

We will examine in turn the causes of these various irregularities, showing the methods employed for characterising and remedying them.

I.—The Dynamo Gives no Current.

3. The causes which may produce this irregularity are as follows:—

A. The residual magnetism of the field-magnets too feeble.

B. Defective contacts.

C. Short circuiting or bad insulation in the working parts of the dynamo or in the external circuit:—(*a*) Bad insulation of the terminals of the dynamo; (*b*) Bad insulation of the brush-holders; (*c*) Bad insulation of the magnet bobbins; (*d*) Short-circuiting in the magnet bobbins; (*e*) Short circuiting of the commutator; (*f*) Short-circuiting at any point of the circuit.

D.—Open circuit in the working parts of the dynamo or in the external circuit:—(*a*) Interruption in the circuit of the field-magnets; (*b*) Interruption in the circuit of the armature; (*c*) The brushes not resting on the collector; (*d*) Interruption in the external circuit.

E.—Reversing of the bobbins of the field-magnets.

4. A.—*The Residual Magnetism of the Magnets too Feeble.*—This defect can easily be discovered by using a piece of iron, which is brought near the pole pieces; and if there is a deficiency of this kind the iron is attracted only very slightly or not at all. The causes of this defect are manifold. It may be due to a current that has been circulating in the bobbins of the magnets in an opposite direction to the normal current; for example, the accidental discharge of a battery of accumulators, reversed connections, &c. The action of the earth's magnetism, or the proximity of another dynamo may also produce the same effect.

To remedy this defect, the dynamo must be separately excited. For this purpose we may employ another dynamo or a battery of accumulators, or even a single battery, and the current is made to pass in a certain direction, through the inductors of the defective dynamo. If, after this operation, the fault still remains, the current is again sent through the inductors, but in the opposite direction.

When the dynamo is wound in series it is sufficient to start it, and when it has attained its normal speed it is short-circuited for a few seconds only, the two terminals being connected by a copper wire. As soon as the excitation is effected, the short-circuiting must be discontinued, or we should run a risk of damaging the machine.

When the dynamo is shunt-wound, we cannot pro-

* *L'Electricien.*

ceed in the same way, for placing the terminals or outer conductors on short-circuit would not produce any excitation; in this case, we must disconnect the outer wires from their terminals, run the machine, and, when it has attained its normal speed, suddenly connect the outer conductors.

5. B.—*Defective Contacts.*—Bad contacts in the different connections of the dynamo may be the cause of the disturbance. In this case, it is sufficient to examine carefully in succession all the connections of the armature and magnets, to clean all the contacts with glass paper and tighten all the screws, terminals, &c., after having well cleaned all the extremities of the conductors leading to them.

When the fault is due to a defective contact in the connections of the various bobbins of the magnets, it may be detected by holding a piece of iron near the pole pieces, but without touching them. If the contacts are good, the iron is attracted uniformly by each of the pole pieces, whereas, if they are bad the magnetic attraction will constantly vary, as we shall know by the shocks or jerks felt in the hand holding the piece of iron.

6. C.—*Short-Circuiting or Bad Insulation in the Working Parts of the Dynamo or in the Outer Circuit.*—This defect manifests itself in shunt-wound dynamos by a slight, but appreciable, magnetisation of the pole pieces.

We must first find out whether the short-circuiting is in the dynamo or in the outer circuit. For this purpose we need only detach the conductors from the terminals of the dynamo, and introduce an incandescence lamp between these two terminals. If the lamp burns regularly, the defect is without doubt in the outer circuit, if not, we must look for it in the working parts of the dynamo, employing the following tests:

7. (*a.*)—*Bad Insulation of the Terminals of the Dynamo.*—The insulation of the terminals is tested by means of a battery and a galvanometer. The battery, P (fig. 1), consists of

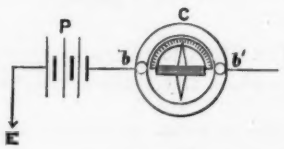


Fig. 1.

three or four Leclanché elements, connected in series; one of the poles of the battery is put in communication with the earth by means of a water or gas pipe, for instance, whereas the other pole is attached to one of the terminals, *b*, of a galvanometer, C; a test wire, fixed to the other terminal, *b'*, is put in communication with each of the terminals of the dynamo in succession. If the insulation is good, the galvanometer needle should not deflect.

We must also test the insulation of each terminal with regard to the framework of the dynamo by connecting the pole of the battery which was connected to earth to some point of the framework, and touching with the test wire each terminal in succession.

8. (*b.*)—*Bad Insulation of the Brush-Holders.*—We proceed, as described above for the terminals, touching with the test wire each of the brush holders in succession.

9. (*c*).—*Bad Insulation of the Coils.*—The testing of the insulation of the coils, with regard to the framework of the dynamo and the earth, is effected in the same way, with a battery and a galvanometer. We must, however, take care previously to detach the outer conductors from the terminals of the dynamo, in order to be quite certain that the fault is really in the machine and not in the outer circuit.

When the coils of the magnets are all badly insulated, and have a loss to earth through the framework, the dynamo gives no current. It may happen, however, that only one of them is defective, and, in this case, the dynamo does give a current, but its intensity is far below the normal.

10. (*d*).—*Short-circuiting in the Magnet Bobbins.*—Short-circuiting in the magnet bobbins may also be the cause of the disturbance. We can, in fact, understand that a derivation with a very low resistance between two points in the winding would absorb the greater part of the exciting current, which, in that case, would no longer pass through the whole of the bobbin. It follows, necessarily, that there would be a diminution of magnetic intensity in the magnets.

When the dynamo is wound in series, the intensity of the current supplied diminishes, and the defective magnet is less heated than one in good condition; if the winding of the dynamo is shunt or compound, the magnets are heated.

11. In order to find the defective coil, the resistance of each must be measured separately, after having first cut off all communication with the circuit. For this purpose a resistance box is used with a Wheatstone bridge, a sensitive galvanometer and a battery of three or four elements. If we do not possess these special instruments, this test may be effected by simply using a battery and a galvanometer which is connected in series with the bobbin to be tested, as shown in fig. 2.

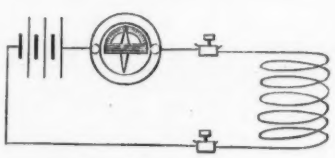


Fig. 2.

By noting the deflection of the galvanometer, for each bobbin, it is easy to find the one in which there is a short-circuit, for it gives a much greater deflection than the others.

12. (*e.*)—*Short-Circuiting of the Commutator.*—Even a slight short-circuiting due to particles of copper establishing communication between various bars of the commutator is sufficient to prevent the dynamo from giving any current. A careful examination of this, accompanied, if necessary, by tests with the battery and the galvanometer, or the bell, will always enable us to find the defective part.

13. (*f*).—*Short-Circuiting at any Point of the Circuit.*—We have already shown (section 6) how to find out whether the short-circuiting is in the dynamo or in the outer circuit. To localise the fault, if this is found to lie in the outer circuit, the conductors which have been disconnected must be replaced quickly in their respective terminals, and at the defective part the fusible cut-out, if there is one, will melt; or, if there is not one, the conductor will be heated and its insulating covering will be burnt. Of course, the greatest precautions must be taken in making this test, or the building might catch fire, either through sparks or through the melting of a conductor at the defective point.

14.—If there is a considerable short circuit, it is probable that when the conductors are replaced at the terminals of the dynamo while working, the belt would slip off the pulley. In this case, the defect might easily be discovered by means of a battery and a galvanometer by the following method:—

We begin by putting all lamps or other apparatus out of the circuit, by disconnecting the conductors communicating with them and letting them hang, so that they are insulated and are not touching anywhere. This done, the conductors of the battery, P (fig. 3), are attached, one to the point of de-

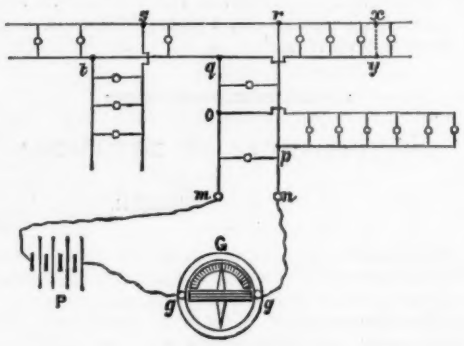


Fig. 3.

parture of the principal conductor, *m*, the other to the terminal, *g*, of a galvanometer, G; a second wire connects the terminal, *g'*, to the other principal conductor, *n*. If the mains are in good condition there should not be any deflec-

tion shown on the galvanometer, the two conductors of the principal circuit being insulated from one another and detached from their terminals on the distribution board. If the contrary is the case, supposing, for instance, that there is a short circuit at $x\ y$, the conductors of all the secondary circuits must be detached at each point of junction ; this done we proceed to test, first the principal circuit and then each of the secondary circuits, $o\ p$, $q\ r$, $s\ t$, in succession. When once the defect has been localised in the section, $q\ r$, it is easy to find it and remedy it. If the test should show that the mains are in good condition, we must look for the defect between this point and the extremity of the conductors ending at the dynamo. We must proceed as above to find the fault, which will lie either in the conductors connecting the dynamo with the distribution board or in the distribution board itself.

15. Any slight short-circuiting, such as is produced sometimes in the supports of incandescence lamps, is sufficient to prevent the dynamo from giving any current.

It is indispensable, therefore, before re-connecting the conductors with the various apparatus on the circuits, if the tests have not shown the defect to lie in the distribution board or in the mains, to examine minutely all these apparatus, making, if necessary, tests with the battery and galvanometer, or with the battery and a bell ; the defect is then soon found.

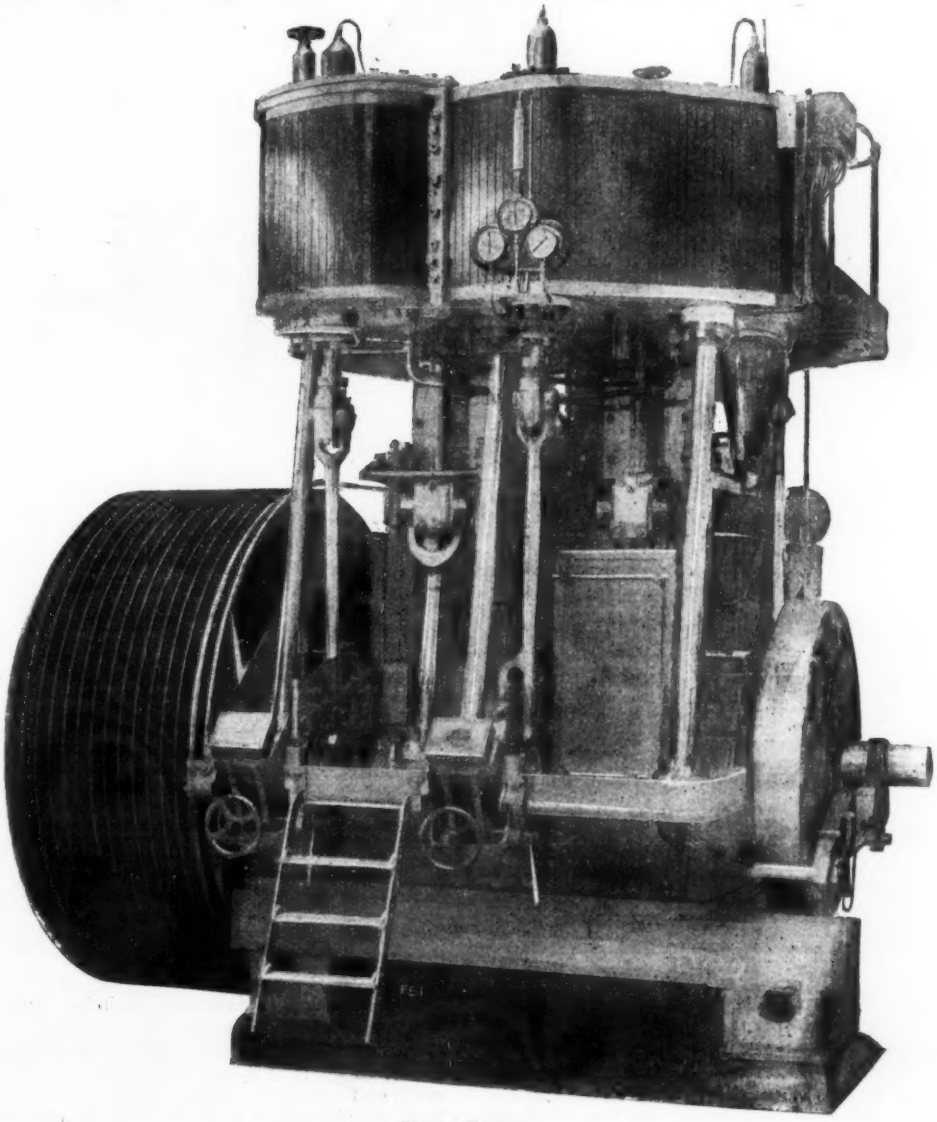
In all these cases when there is found to be a short-circuit in the outer circuit, the latter must be insulated from the dynamo until it is repaired.

(*To be continued.*)

ELECTRICITY SUPPLY STATIONS.

No. 13.—Huddersfield Corporation Works.

The question of electric lighting was delegated by the Corporation to the Gas Committee, who visited a number of towns to inspect the various systems ; after very careful consideration of the respective advantages offered, they decided that the balance was in favour of distribution by low pressure, with generation at high pressure by alternate currents. The tender of the Brush Electrical Engineering Company being accepted, application was duly made to the Local Government Board for powers to raise a loan ; sanction was obtained in May, 1892, when the buildings were promptly commenced. In July, however, an untimely strike in the masons' trade so delayed the work, that all hope of completing in time for last winter was abandoned. Public supply practically commenced last July.



Brush Engine.

The Generating Station.

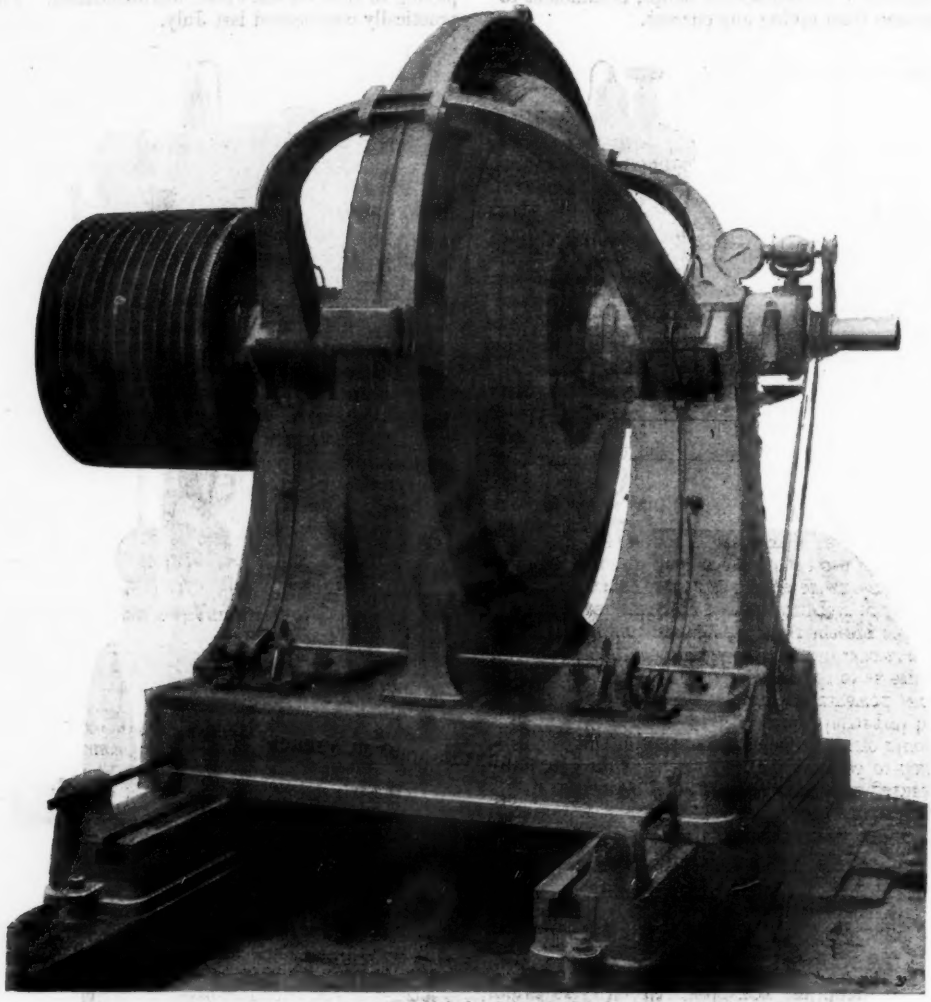
The generating station is situate on land adjoining the canal and the Corporation Gasworks. The buildings, which are most substantial, have a frontage in St. Andrew's Road of 117 feet, the engine room being 105 feet long by 50 feet wide ; the boiler house is the same length, and 54 feet wide. The buildings have been specially designed with a view to facilitate the carrying out of future extensions, while at present plant for 40,000 lamps can be conveniently accommodated.

To obviate running two engines during light load,

there is fixed on the shaft of the 50-kilowatt alternator a small two-pole exciter. The exciting omnibus bars are fed from two Victoria dynamos, each coupled direct to a 6 inches by 5 inches Brush engine running at 400 revs., and each capable of an output of 4,500 watts at 65 volts; this is sufficient to excite generating plant of 500 kw. capacity.

The Engines and Dynamos.

There are three engines, two of which have cylinders 15 inches and 25 inches with a 16 inch stroke, and they are run at 167 revs. per minute. The high pressure cylinders are fitted with piston valves, and the low pressure with slide valves. They are controlled by a fly-wheel governor acting on the high pressure valves; the governor is fitted with Raworth's patent adjustment for altering the speed while running, and for dividing the load as required between the various machines running in parallel. The L.P. slide valves are provided with Hackworth's gear for varying the cut-off in the low pressure cylinder whilst running, so that the engines may be operated for any load with the best results. The small engine is similar to the larger engines, except that an Acme throttle valve governor is used; the cylinders are 11 inches and 18¼ inches diameter with a 12 inch stroke, and the speed 200 revs. per minute. We illustrate one of the larger engines.



The alternators are of the Mordey-Victoria type, and are driven from the above engines by means of separate cotton ropes. Two of these run at 430 revs., and have a capacity of 100 kilowatts each, whilst the third runs at 600 and works up to 50 kilowatts, the pressure being 2,000 volts.

Switchboards.

The "unit" system, as it is called by the Brush Company, has been carried out in this station; each exciter has a switchboard with ammeter and zero cut-out arranged for running the compound-wound exciters in parallel on to the exciter omnibus bars. Platinoid resistances wound on bars of slate, with a sliding contact, are used in the shunt circuit for regulating the pressure of the exciters, and, through them, of the whole station. The station voltmeter is fixed immediately over these resistances.

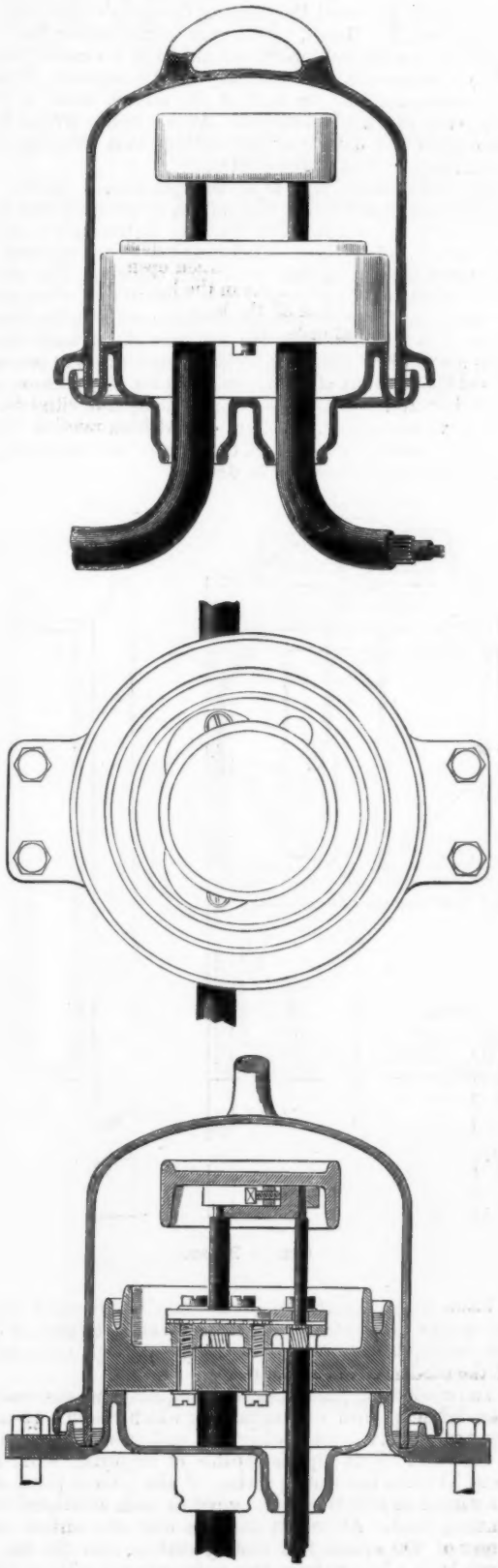
The field of each alternator is connected to the exciting mains by a special switch, which puts in a water resistance when the circuit is being opened, and so obviates the effect of a sudden opening of the field circuit. Opposite each alternator there is a board containing double-pole high tension fuses and switches for connecting the machine to the station omnibus bars, and also an alternate current ammeter, a voltmeter on one coil of the armature, and an ammeter on the field circuit. There is also a small double-pole plug switch for connecting the alternator to the synchroniser.

The synchroniser board contains two synchronisers and lamps, together with double-pole switches for connecting the synchroniser to the station omnibus bars. It also carries the main station ammeter and the main station recording meter, which is of the Shallenberger type, while provision is made on the board for a recording wattmeter. After passing from the alternators to this board, the omnibus mains proceed to the circuit boards, of which at present there are two; each carries an ammeter and double-pole high tension switch and fuse. We illustrate one example of each of the above boards.

The system permits the addition of any number of exciters, alternators, circuits, and their corresponding boards, without interfering with the existing arrangement.

The switchboards are operated from a gallery running along two sides of the engine room, and are placed so as to correspond with the machines to which they belong. Access to the gallery is obtained directly from the offices of the

electricians, which are on the first floor, or by circular stairs from the engine room.

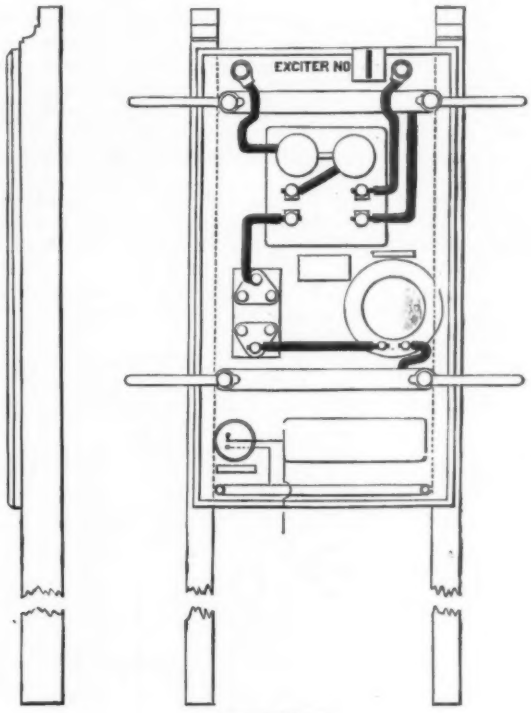


Brush Dry Joint Box.

Testing Wires.

Wires are run from the testing room to various parts of the machine room, where terminals are fitted for rapid connection with any of the machines and circuits. A very complete set of testing instruments has been provided.

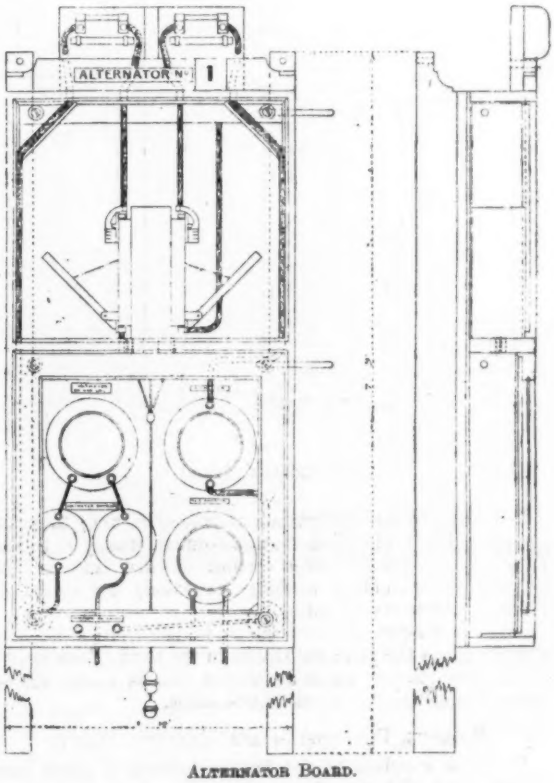
The whole of the engine room plant has been manufactured by the Brush Company at their Loughborough works.



Exciter Board.

Method of Distribution.

The distribution is effected at 100 volts pressure by low tension distributing mains running from transformer sub-



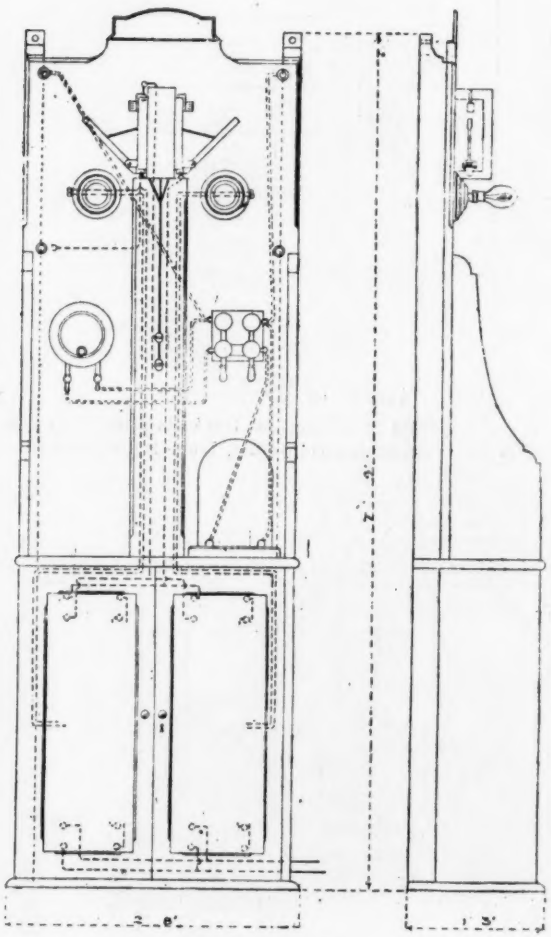
Alternator Board.

stations; the low tension network is supplied through transformers by either of the two high tension feeding circuits.

The advantage obtained by this system, the joint patent of Messrs. Raworth and Geipel, is, that any of the high tension circuits may be shut off for testing, repairs, or extensions, without necessitating a discontinuance of the low tension supply.

The conduits for both high and low tension mains are on the Callender-Raworth system, consisting of specially prepared paper tubes embedded in bitumen; there are four such tubes leading from the generating station, and into these have been drawn two vulcanised rubber high tension concentric cables which run to the transformer chamber at the corner of Northumberland Street and John William Street, whence they diverge.

The high tension joints (see illustration) are of the Raworth-Geipel type, which have many advantages over the ordinary vulcanised rubber joint; the joints being mechanical are very easily made, and can be inspected by merely lifting off the cover, while the cable may be easily disconnected for testing. No trouble has been yet experienced with these joints.



Synchroniser Board.

Four transformer stations are at present in use; they are equipped with Mordey-Victoria transformers, mostly of 18 kw. They are constructed with earthed shields between the primary and secondary windings, to satisfy the Board of Trade requirements for safety.

The low tension network which is fed from these substations serves the principal streets in the town. The length of the low tension mains at present laid is about 10,000 yards, and of conduit about 15,000 yards.

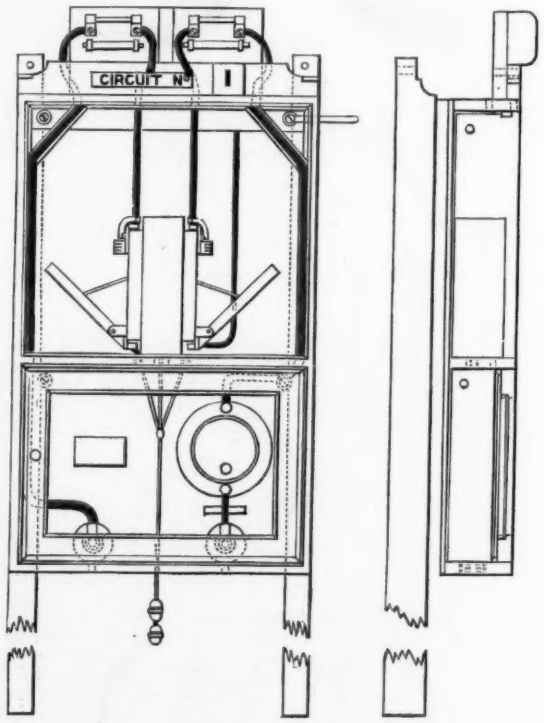
Boilers, Condensing and Feeding Plant.

Steam is supplied to the first instalment of plant from four Babcock-Wilcox boilers, each capable of supplying about 5,000 lbs. of steam per hour at 150 lbs. pressure. Each boiler has a heating surface of 1,411 square feet, and a grate area of 26½ square feet, and each has 63 tubes, 4 inches diameter and 18 feet long, with a steam drum, 36 inches diameter and 23 feet 7 inches long.

The brick setting of the boilers has been specially designed by the Brush Electrical Engineering Company's superintending engineer, Mr. Geipel, with a view to minimising loss by radiation from the brickwork, and although no careful tests have yet been made, some economy may be expected. It has been ascertained that the heat of the outside walls is less than with the usual settings. An air space divides the inside from the outside of the setting, thus reducing the transmission of heat to the outside.

The main steam pipe is of wrought-iron, 6 inches in diameter, and forms a ring with valves, so arranged that any section may be isolated. The branches to the main engines are 4 inches and 3 inches. Reducing valves are inserted in each steam pipe to operate the exciter engines. The whole of the valves are of the parallel slide type, so that when open the steam has a straight passage through; while in the larger valves it is arranged that the first turn of the hand wheel opens a small bye-pass valve, which at once serves to prevent too sudden an influx of steam, and relieves the pressure on the main valve, so that the latter may be opened with ease.

The exhaust piping, which is of cast-iron, ranging from 10 inches diameter downwards, opens into the condenser or direct to atmosphere as may be desired.



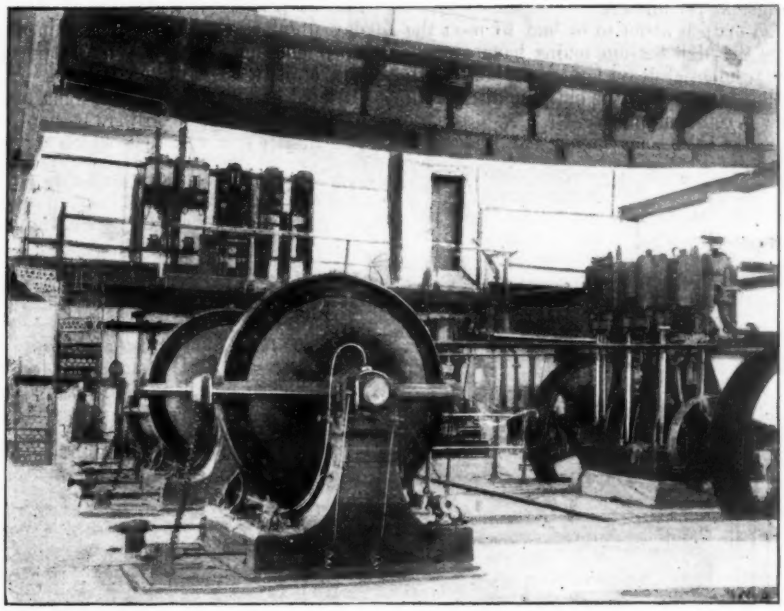
Circuit Board.

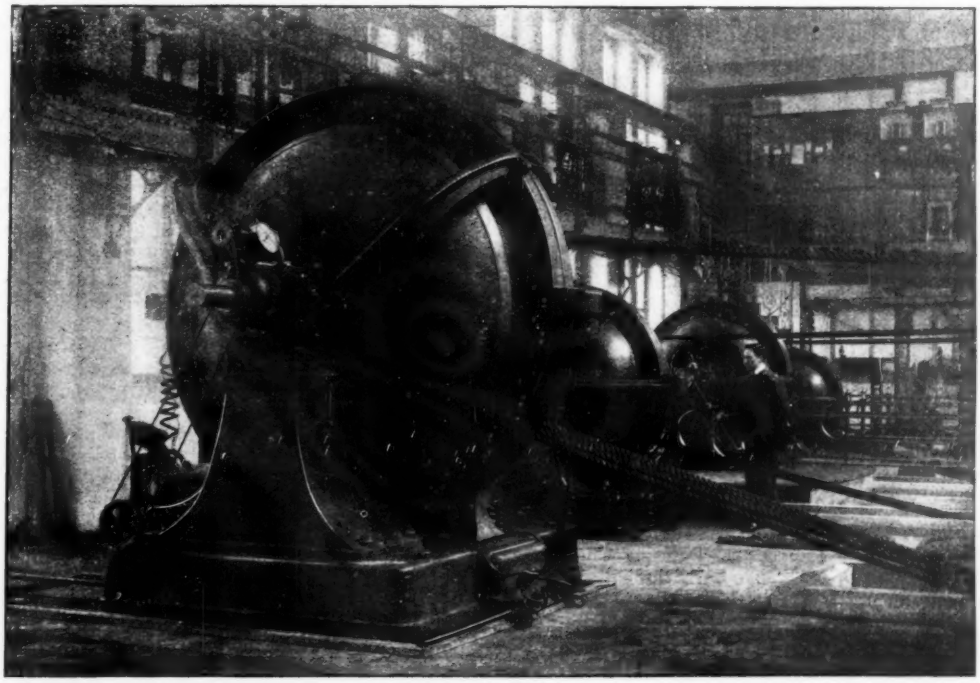
There is an automatic relief valve on the pipe, which opens the exhaust to the atmosphere in the event of stoppage of the condensing plant, while a large straight through valve shuts off the condenser when required.

The condensing plant is so arranged that it may be readily extended along with the engines, for which reason a 16-inch pipe has been fixed for leading the cooling water from and to the canal. This pipe is capable of supplying water for about 10 times the cooling surface of the present plant, and is arranged so that it may be tapped as each additional condenser is fixed. At present there is only one surface condenser of 900 square feet cooling surface, into the top of which leads a branch from the main exhaust, with a valve for closing the inlet.

The Raworth air and circulating pumps are horizontal, and are fixed on one bedplate, and are driven by a pair of compound cylinders. This combination has been specially designed for central station work, with a view to economising the consumption of steam. The whole of the pumps are

worked by one pair of compound cylinders, while a heavy fly-wheel is provided to enable the steam to be cut off and used expansively. The diameter of the air-pump is 13 inches, the circulating pump is 11 inches, the H.P. cylinder 5 inches, and the L.P. cylinder 8½ inches, and the stroke of each is 10 inches. A bye-pass valve is fixed on the circulating pump, pump, a replenishing cock being fitted to both the town supply and to the circulating or canal water pipe, so that the feed may be made up from either source. In addition to this there is a Worthington pump supplied as a standby; this pumps direct into the boilers from either town supply or canal pipe. The feed pipe is also arranged on the ring main





Dynamo Room.

in order to control the cooling water to suit the quantity of steam to be condensed, and to regulate the temperature of the hot well. A general idea of the pump may be obtained by reference to the plate.

The principal feed pumps are driven from a rocking shaft by the engine which drives the air and circulating pumps. The pump rods are attached to blocks which slide in slotted levers, by means of which the stroke may be varied as required. The feed water is drawn from the hot-well under the air principle, with suitable valves for isolating any section. The branch feed pipes are entirely of copper.

The engine and dynamo room is traversed by a 15-ton crane, operated either by hand, or by a 9 H.P. Brush Victoria motor, current being obtained from one of the exciters.

Extensions.

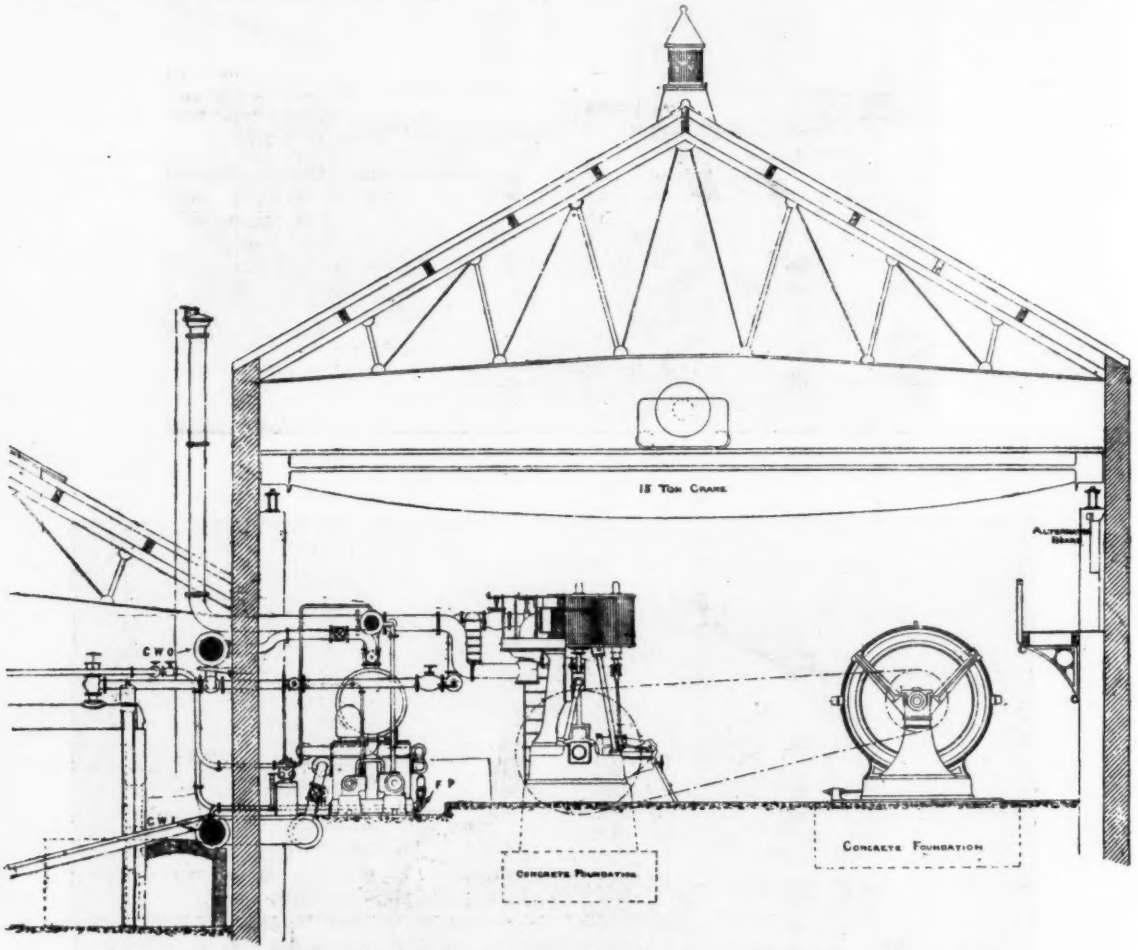
The light has been taken up in a most satisfactory manner; indeed, so great has been the demand, that before the station

was put to work, an order was placed with the Brush Company to double the capacity or the plant in time for this winter's supply.

The new plant consists of a 250 kw. Mordey-Victoria alternator, running at 300 revolutions, driven by means of cotton ropes, and a Brush engine, having cylinders 18 inches and 32½ inches diameter, and a stroke of 20 inches; it is in most respects similar to the smaller engines already described, and runs at 150 revolutions per minute.

A third high tension main is about to be laid to meet the increased demand, and the high tension mains have already been extended to the residential district up the New North Road. It is interesting to note that the outlying districts in Huddersfield are already being supplied.

The whole of the works have been carried out under the supervision (on behalf of the Huddersfield Corporation) of Mr. A. B. Mountain, borough electrical engineer, and generally under the control of the Electric Lighting Committee, the individual members of which have throughout taken the greatest interest in the scheme. The general design and the equipment has been in charge of the Brush Company's contract department and staff, under the control of Mr. W. Geipel, their superintending engineer, assisted by Mr. S. A. Mahood as resident engineer.



C W, O, circulating water outlet to canal; C, W, I, circulating water inlet from canal; F, P, feed pump suction from hot well

Sectional View of Station.

TWO HUNDRED DEGREES BELOW ZERO.

Whether it were pleasanter to be 200 degrees below zero, or pressed flat in the top gallery of the Royal Institution, must be left to conjecture, but it did seem on Friday night as if a little "local cooling" by liquid oxygen would have been acceptable. Prof. Dewar's lecture was brilliant, and his experiments successful. Nearly an hour before the lecture a distinguished audience burst into the Institution, flung overcoats, hats, and umbrellas on the floor of the cloakroom, and then gallantly fought its way into the lecture theatre. It was a time when marvellous feats were accomplished in squeezing through small places; it is really surprising into what space you can squeeze a man when you don't know him. So great was the crush that even famous personages had a difficulty in retaining their everyday dignity. Worthy and dignified professors were piled upon one another in the most lamentable manner, and the end of it was that each received from the doorkeeper a battered and broken hat, and went home in the rain. Prof. Dewar and his oxygen were perhaps the only cool bodies in the theatre; it was that which aggravated things. It is difficult to see the exact uses of liquid air, but that may be due to lack of imagination.

The first point of importance brought to light was that at absolute zero all metals have the same degree of conductivity to electricity, however much they may differ at higher temperatures. The behaviour of mercury vapour in very high vacua was at low temperature very curious; by cooling a portion of the vacuum tube the mercury was deposited on the side; the same was found with a vacuum tube containing iodine. A most curious experiment was the effect of low temperature on electrical discharges through vacuum tubes; by cooling a portion of the tube with liquid oxygen, the resistance became so high that phosphorescence entirely ceased and the discharge found another path. "What did this mean," said the Professor. "Obviously that something was now frozen out, which had before enabled electricity to pass across the vacuous space." Amongst many other interesting facts announced by the lecturer were the effects of extreme cold on the cohesional power of metals. The tensile strength of iron at — 180 C. is just twice what it

is at 15 C. It will take a strain of 60 instead of 30 tons to the square inch, and equally curious results have come out as to the elongation of metals under these conditions. It was an idea of Faraday that the magnetism in a permanent magnet would be increased at very low temperatures; experiments with comparative low temperatures had rather negatived Faraday's suggestion, but Dewar has completely verified the opinion of the famous *savant*, for he has found that a magnet at — 200 degrees C. has its power increased by 50 per cent., and, what is more, he showed this to the audience on a magnified scale. Low temperature was found to have a remarkable effect upon the colour of many bodies. For example, the brilliant scarlet of vermilion and mercuric iodide is reduced under the influence of intense cold to a pale orange. Prof. Dewar threw out many suggestions of what may be accomplished at these low temperatures. For our own part, we think that at this low degree, transmutation of metals, transmigration of souls, and a "living wage" ought to be obtained with the greatest ease.

CORRESPONDENCE.

Frequency.

I notice in your issue of December 29th a reference to my "Liquid commutator" device for low frequency currents, and comments on the latter. The device was arranged for laboratory purposes, the therapeutical effects of such currents being alluded to only as an unexpected result of possible interest. Medical men familiar with these uses of electricity, have expressed surprise at the result. I can cite but one test case. I believe it cured rheumatism in my elbow, which disappeared after a little dosing, while discharges from a "Wimshurst" machine, previously administered in the usual way, aggravated the trouble, if anything; but I do not pretend to be an expert in this branch.

In this same issue, referring to the Tesla oscillator for "high frequency currents," you make mention of Prof. Ewing's high frequency alternator, driven by a steam turbine at 20,000 revolutions a minute, which, if the machine had, say, 48 poles, would mean only about 16,000 reversals of potential a second, which is low compared with the possibilities of my "multi-frequency machine" for obtaining high frequency currents at known and fixed rates by mechanical means.

This device is described in the New York *Electrical World* of November 18th, and again referred to in their issue of January 6th, 1894.

In view of the attention given the low frequency apparatus, I am naturally surprised to find the "high frequency device," a far more important and novel apparatus, scientifically pass unnoticed. With it frequencies in the hundreds of thousands are doubtless possible, with safe mechanical speeds and light dynamo apparatus.

F. Jarvis Patten.

New York, *January 10th*, 1894.

Central Station Engines.

The discussion at present being carried on in the electrical papers, with regard to the plant to be adopted at Newport, seems to be taking a personal and unworthy tone.

This is much to be regretted, as electrical engineers, above all others, should bring to the consideration of their plans an unbiassed and impartial mind.

It tends now, however, to bring to a definite head the long-standing dispute as to the type of engine most suitable for central station work. This is a subject of paramount importance at the present time, when most municipal bodies are undertaking the responsibility of spending large sums of money upon central stations, and which, if spent upon unsuitable plant, must necessarily place them in an undesirable position; for though, as a matter of course, they act upon the advice of technical experts, any mistake made must affect their finances prejudicially.

Unsuitable plant also reacts unpleasantly upon the resident engineer who takes charge of the station on completion, and who has to do the best he can with the plant provided.

Messrs. Willans & Robinson have thrown down the glove on behalf of "direct-driving" generally, and of their engines in particular, and condemn, as "obsolete and inefficient," the plan of driving dynamos by ropes or belts.

So far, the makers and users of this undesirable combination have not taken up the challenge, and in view of the fact that central stations upon both systems have been running for a sufficient length of time to furnish reliable data, it is strange that the various consulting engineers and electrical experts should not have brought the question to a definite issue ere this.

From an analysis of the published particulars of the central stations in operation in the United Kingdom, I find that in London the total horse-power installed in Willans and other direct-driving engines amounts roughly to 16,000, and the total amount transmitted from other types of engines, by means of ropes and belts, is also about 16,000 H.P. The rest of the central stations outside London total some 17,000 horse-power in direct driving (of which about 14,000 H.P. is from Willans engines), and the H.P. transmitted by ropes and belts is about 14,500.

I also gather that "direct driving" is principally used in connection with "low tension" distribution and secondary batteries, and that ropes and belts seem to be preferred for "high tension" work and alternating currents. This, of course, may be only a coincidence.

The consulting engineers who are responsible for these stations appear to be divided in opinion as to the type of engine and the mode of driving, and, if it be true, that but one of these systems is correct, I consider that, in the interests of this growing industry, it is quite time the subject should be fully ventilated.

The most important point to be borne in mind when selecting the "prime mover" for a central station must be "reliability of running," and as all engines are liable to develop a fault at some time or other, it is advisable to select one which permits of the principal working parts being kept under constant observation, so that the defect may be known at the earliest moment, and an opportunity given to rectify it before a breakdown results.

Another point should be the "all day" efficiency, not simply selecting the engine which gives the highest efficiency at one special load, but which may be more wasteful than another type during the varying local requirements of a 24 hours' run.

There is also the question as to which system is best adapted for "parallel running," whether alternating or direct currents are used. Many minor points might be raised, but the broad question between the two systems must first be decided.

M. Ruddle.

English Made Carbons.

Our attention having been drawn to a statement made in several of the electrical newspapers that "all carbons used in England for arc lighting have hitherto been imported from abroad, we should be obliged if you would correct this statement, which is inaccurate.

We have been engaged for over 15 years in the manufacture of carbon rods for electric lighting. These carbons have been made under English patents, and at our works at Silvertown we have a complete plant in daily operation for the production of such carbons for electric lighting.

Trusting that you will insert this contradiction in an early issue,

India-Rubber, Gutta-Percha and Telegraph Works Company, Limited.

WM. J. TYLER, *Secretary.*

January 22nd, 1894.

Examination Question.

Will you please give a formula which will enable me to solve the following, set at last year's "ordinary grade" examination:—"A 4-pole motor armature, 24 inches diameter, series-wound, with 202 external conductors, takes 300 amperes at 210 volts. Flux of lines from one pole 9,000,000 C.G.S. measure (or 1,500 lines English measure). Assume field magnets to be separately excited, and armature to work with 95 per cent. efficiency. Find (*a*) speed;

(*b*) horse-power; (*c*) tangential pull of armature conductors?"

H. W.

January 16th, 1894.

[Let E = volts, N^t = conductors on armature, T = torque, Z = flux of lines from one pole, n = number of revolutions per minute, C a = current.

$$\text{Speed} = \frac{E}{N^t\ 2\ Z} \text{ for a 4-pole machine.}$$

$$\text{Horse-power is equal to } \frac{2\ Z \times N^t \times n \times C\ a\ 10^{-6}}{746}.$$

$$\text{Pull on armature conductors} = C\ a \times \frac{N^t \times Z}{2\ \pi},$$

or, if for one conductor, pull = C Z l where C is current in absolute units, Z lines per square centimetre, l = length of conductor in the field in centimetres.

Prof. S. P. Thompson's book on "Dynamo-Electric Machinery," and Kapp's book on "Electric Transmission of Power," should be referred to by the student for full instructions regarding these questions.

The horse-power might also be found by $\frac{E \times C\ a}{746}$, and the pull on the conductors by $\frac{\text{Horse-power} \times 33{,}000}{\text{speed of conductors in feet per minute}}$, and the result divided by the number of conductors and number of poles would give average pull on one conductor.

As 95 per cent. is the efficiency stated, then 95 per cent. of the horse-power found by $\frac{E \times C}{746}$ would be the actual horse-power with separately excited magnets.—Eds. Elec. Rev.]

Lightning Express Railway Scheme.

The remarks made in his presidential address by Mr. Siemens on the subject of high speed electric railways, appear to have produced the impression among many that such schemes are far without the bounds of practical engineering. He does not discriminate: he includes all rapid transit schemes under one common ban. Now, on November 9th and 11th last, shortly after the announcement was published that we had undertaken to develop the experimental work in connection with Mr. Behr's lightning express single rail railway scheme, Mr. Siemens signed and addressed to this company letters in which he offered to supply our requirements as regards the electrical portion of the work, and to place the experience of his company at our service. We think, therefore, in view of such public pronouncement as that referred to, that we are justified in publicly calling Mr. Siemens's attention to the discrepancy between the expressions of the speech and of the letters.

The Thames Iron Works and Shipbuilding Company, Limited,
C. E. Grove, *Electrical Engineer.*

Correction.

In No. 842 of the Electrical Review of the 12th inst., you give a notice on page 45 of the latest business report of the undersigned, which we have read with great interest. In this notice there is a deplorable error. You state that our company was formerly known as Schückert & Co., of Nürnberg. We desire to inform you that our company is in no way connected with the firm of Schückert & Co., but was in 1883 established in Berlin as the "Deutsche Edison Gesellschaft" (The German Edison Company), for the supply of electricity, which name was, in 1887, incorporated in the Allgemeine Elektricitäts-Gesellschaft, owing to the rapid and extensive development of our undertakings having soon taken the active sphere of our company far beyond the German boundaries. We beg that you will correct this erroneous statement in your journal.

Allgemeine Elektricitäts-Gesellschaft,
E. Ratlunn.

LEGAL.

The Edison-Bell Phonograph Corporation, Limited *v.* Smith and Another.

The hearing of this action was commenced before Mr. Justice Wright, sitting in the Queen's Bench Division at the Law Courts, on Tuesday. The action was brought in respect of the infringement of Mr. Edison's 1889 patent, No. 19,953, relating to phonographs. The defendants, Mr. G. A. Smith, of Brighton, and Mr. Young, who carries on business in Fore Street, London, E.C., pleaded, amongst other things, that the patent set up by the plaintiff company had been anticipated.

The counsel engaged were Sir R. Webster, Q.C., Mr. H. F. Moulton, Q.C., Mr. Bremner and Mr. J. C. Graham for the Edison-Bell Phonograph Corporation; Mr. R. B. Finlay, Q.C., Mr. Bousfield, Q.C., and Mr. Lewis Edmunds for the defendants.

Sir R. Webster explained that the phonograph was an instrument which recorded and reproduced articulate sounds. They were reproduced from a simple piece of metal, which vibrated so as to create air waves. The instrument was practically all worked out by Mr. Edison and another gentleman, but in this case the whole of the parts infringed were by Mr. Edison. Mr. Edison began to work on the subject 16 years ago. His investigations were interrupted by telephone business, but were resumed after an interval of 10 years, when he and a fellow countryman discovered contemporaneously that to make an effective phonograph, the recording style should not indent, but cut. In the course of further development, Mr. Edison discovered a very remarkable step in advance, which might be called the leading invention in the specification. In phonographs, up to the month of November, 1889, there had been employed two diaphragms one to make the impression, and the other to reproduce the speech. You spoke to one diaphragm, and its tool cut the revolving cylinder as the diaphragm was moving from right to left; another was then used with its tool to reproduce the speech when you wanted it. They were mounted on what might best be described as a spectacle frame. For all phonographic purposes, assuming everything to work well, that was a perfectly successful instrument. But it was found to involve practical difficulties which rendered it commercially unsuccessful. Amongst other things, there was the necessity of having to adjust the two diaphragms, the instrument being one of extreme delicacy. Mr. Edison devised a step which was as important as any that had ever been taken in connection with this matter. He put both tools on one diaphragm. It was important, in order to appreciate what had been done, to notice the extreme delicacy of the instrument he had to deal with. He (Sir R. Webster) was not exaggerating when he said that the practical obstacle to commercial phonographs was to get over the difficulties of adjustment in the very minute points, which had to act in an absolutely certain way, as any irregularity of pressure, or irregularity of cut, would render it of small commercial utility. The broad distinction between Mr. Edison's present phonograph, and the most successful produced before it, and which was the principal claim in the invention before the Court, was in the doing away with the necessity of having two diaphragms upon a combined frame or frames separate from one another, each governing its own tool—one the cutting or recording tool, the other the reproducing tool. They were under the present patent both put together. Gentlemen acquainted with the whole of this discovery in America, and gentlemen of scientific position in this country, would be able to satisfy the Court of the extreme importance of this step. Commercially, it made the whole difference between success and failure. Then there was another matter. In using one diaphragm instead of two, it was found that while the new method removed difficulties, it created other minor troubles which had to be got rid of. Different kinds of mouthpieces were used for recording and reproducing. The two diaphragms each had been fitted so that it would receive its proper mouthpiece. When, therefore, you got a common diaphragm, it was necessary to provide so that it would only receive the mouthpiece when it was in the proper position, and the ear-piece when it was in right place. It was requisite that the diaphragm, according to its position, should be selective. When it was in the recording position it should only receive the mouthpiece, and when it was in the reproducing position it should only receive the ear-piece. That had to be brought about by an invention which, although subordinate, was of considerable merit. There was also another contrivance which was not, perhaps, so distinctive as the principal matter to which attention had been called. To obtain ease of removal of the wax cylinder it was necessary that one end of the axis upon which it revolved should be open, and you lifted one of the bearings. Of course it was all important that it should be in constant and uniform position, and a screw was used for the purpose of adjustment. The amount of screwing up that might be done by an unskilled person was an unknown quantity. An ingenious and novel modification was therefore introduced by Mr. Edison in the shape of a stud. His Lordship would be able to follow the specification. He (Sir R. Webster) would decline to assist the defendant's case by going into the alleged anticipations at that stage of the proceedings. In effect they said that Edison's previous inventions had anticipated the patent now sued upon.

Dr. John Hopkinson, in reply to Mr. Moulton, said he had considered the specification and letters patent set up in this case. The inventions claimed were, in his opinion, adequately described. They were, so far as his knowledge went, both novel and useful. For many years Mr. Edison had been taking out patents in respect to the results of his work. One difficulty after another had been removed. In the present patent you had one diaphragm instead of two, and the advantage of different shaped points. There was a very clever contrivance for lifting the diaphragm and propelling screw away from the cylinder. It was in working often necessary to pause. Mr. Edison had enabled one to lift away the necessary mechanism with-

out stopping the uniform revolving of the cylinder. That was vital for any practical use of the phonograph for the purpose of recording or reproducing. The method was extremely simple. There was also an arrangement for turning off the old record. The witness described the minor arrangements relating to the invention. He said he had read the alleged anticipations relied upon by the defendants. He did not agree that they were anticipations.

Cross-examined by Mr. BOUSFIELD: Until recently he thought the phonograph had not been produced that was suitable for practical everyday use. He recollected Mr. Edison had a machine that was made before the date of the patent now at issue, exhibited in this country in 1889.

Mr. BOUSFIELD explained to his lordship that the importance of the circumstance was that the Crown could not re-grant anything that it had re-granted in a prior patent.

Further questioned by Mr. BOUSFIELD, Dr. HOPKINSON said he believed the machine produced by the defendants was substantially in accord with the specification (one of Mr. Edison's) handed to him. The 1889 spectacle-frame machine was, if perfectly adjusted, as effective, perhaps, as the more recent phonograph. He had reasons for thinking the prior instrument was more difficult to adjust than the later one.

Mr. JUSTICE WRIGHT: May I ask Sir Richard Webster why the infringing machine was not treated as an infringement of patent No. 7,794.

Sir RICHARD WEBSTER: Because the later patent (19,953) described the actual machine which the defendant was using.

Mr. BOUSFIELD: No. 7,794 is a spectacle-framed machine.

Mr. JUSTICE WRIGHT: Proceed with the cross-examination, if you please.

Mr. BOUSFIELD: Dr. Hopkinson, are you aware that in the machines manufactured by Mr. Edison in 1879 or 1880 he had already made the step of having a single diaphragm?

Dr. HOPKINSON: My impression is I saw a machine with one diaphragm, but you had a single recording point which also served for reproducing, and you had to produce your recording by impressing instead of calling down.

If in 1889 you had told a workman to produce a machine with one diaphragm carrying two points, would he have been able to make one?—I think it very likely he might have.

Would it have required ingenuity on the part of a workman experienced in making phonographs?—I do not care to give an opinion as to what does or does not constitute ingenuity, unless compelled.

Cross-examination continued: Claim 2, having reference to the floating weight, constituted a new combination. The apparatus described in Claim 3 did not refer to a single diaphragm frame with the recording and reproducing point, unless it were imported by the words "The diaphragm frame." The witness was then minutely questioned in regard to the different specifications, more particularly as to what was new in the more recent. He was still under examination when the Court rose for the day, and the further hearing was adjourned until Thursday.

BOOKS RECEIVED.

Electro-Magnetic Theory. Vol. I. By OLIVER HEAVISIDE. Publishers: *Electrician* Printing and Publishing Company, Limited.

Electric Transformation of Power. By P. ATKINSON. Published by Crosby Lockwood & Son.

Electric Waves. By the late Dr. HEINRICH HERTZ. Translated into English by D. E. Jones, B.Sc, with a preface by Lord Kelvin. Publishers: Macmillan & Co.

English Illustrated Magazine for February. Published at the *Illustrated London News* Office.

BUSINESS NOTICES, &c.

The Universal Electrical Directory (J. A. Berly's).—The above directory is now in the press, and all orders for the 1894 issue, should be forwarded at once to H. Alabaster, Gatehouse and Co., 22, Paternoster Row, London.

Calendars, Catalogues, Lists, &c.—The seventh edition of their Annual Export Catalogue of Machinery and Hardwares, manufactured by the principal British firms, has been published by Messrs. John H. Hackworth & Co., of Queen Victoria Street. Engines and boilers, engineers' tools, and machinery of every description are dealt with, and profusely illustrated.

The General Electric Company, Limited, have just brought out the fifth edition of their illustrated catalogue of Telephones and Telephone Accessories. The necessity for the re-issue of this catalogue is attributed by the company to the great progress made in telephone engineering. All instruments connected with the telephone industry are afforded a suitable position. In transmitters, the publishers have confined themselves to two types, *i.e.*, the Hunnings cone and the Johnson, both of which may be had made up in combinations, adapted to all requirements—magneto call, battery call, wall and table use. A combination, worthy of notice, is No. 350, which consists of Hunnings cone microphone with relay and battery bell for railway and signalling work. The transmitters described are all made up with either double pole bell, ring magnet, Manchester watch, or loud speaking receiver. To illustrate the qualities of the last mentioned receiver, the company have rigged up a life-sized Jack Tar as a speaking automaton. This is on show at the company's establishment. No. 321, plugboard, is specially suitable as an intercommunication system for employment in sets of offices. Since the catalogue went to press, the company have produced the "General" system, for which are claimed many advantages. Other methods of line selection, such as annunciators, switchboards, &c., are treated in the catalogue, as are, also, batteries, aerial line wires, multiple telephone cables, line stores, insulators, tools for line construction. Diagrams and instructions are added, showing how all the instruments may be connected either for single calls or intercommunication purposes. Estimates follow, showing the approximate cost of complete systems at a glance. At the end of the book appear descriptions of the microphone transmitter, the telephone receiver, full information respecting line construction, particulars of how the most frequent faults arise and their remedies. A list of the most useful books of telephony is subjoined. The company has also sent us a circular of the Edison-Lalande battery, descriptive of its construction, resistance, capacity, &c. This battery has been largely taken up for oil engine work.

Messrs. Clarke, Chapman & Co., Limited, have sent us one of their 1894 calendars. The illustration, which shows a search light shedding its bright rays upon a small set of lighting plant, is really of the first class.

The English Electric Carbon Company, Limited, of Brymbo, near Wrexham, have just brought out a price list of the "Phœbus" carbons. Some observations, which may be said to be a concise history of electric arc lighting, are exceedingly interesting. The prices are given per foot and per 1,000 feet. Telegraphic code words are given for the various sizes. Some useful tabular statements regarding average time of lighting during three years, and the rate of consumption of carbons in arc lamps with continuous currents are also included. On the front page of the list is a reproduction from a photograph of an electric arc with continuous current.

Messrs. Mather & Platt, Limited, have sent us copies of some well-prepared lists of their "Manchester" dynamo, alternate current dynamos for central stations and private lighting, the Edison-Hopkinson dynamo, and the Edison-Hopkinson motor. The lists are all illustrated by first-class blocks, and very good paper has been used. On the whole, the pamphlets are nice neat productions. Some very useful particulars regarding the machinery described are published.

The Keighley Engineering Company have forwarded us a circular descriptive of their manufactures in the way of wood-working machinery, machine tools, lathes are made a speciality.

Mr. C. Rettie, of Liverpool, has sent us a highly coloured calendar for 1894. Colour has been distributed lavishly, without any idea of consistency. An electric tramcar is shown at the bottom of the calendar with the words "*Thompson-Houslen system*" printed in large type on the outside. Which system is this? Is it the *Thomson-Houston?*

Messrs. Faraday & Son, of Berners Street, have sent us a new list of their No. 21 lamp standard. We understand that this design has been so much appreciated that the firm has decided to modify the process of manufacture, thereby reducing the cost.

Messrs. O. Berend & Co. have just brought out a new illustrated list of the Berliner telephones. The book deals exclusively with telephones and telephonic accessories, and will be very useful to the firm's customers. We understand that at the Chicago Exhibition, last year, the Berliner telephones received the only award given for microphones.

Taunton Electric Lighting.—The following report of the Electric Lighting Committee was recently accepted by the Town Council:—"Your committee report that the borough surveyor and Mr. Couzens have been to London and had an interview with Dr. Fleming as to the proposed extension of the works. Your committee report that owing to the burning out of an armature it was found necessary to procure one from Messrs. Laing, Wharton & Down; their price for same is £55, and the committee recommend that it be purchased, and that the one which has broken down be repaired by Messrs. Newton. Your committee report that 33 small meters are required at once, and they have ordered that a sample meter be forwarded by Messrs. Laing, Wharton & Down to Dr. Fleming, and if he approves thereof, that three dozen be ordered. Your committee report that there is not sufficient old wire in stock to carry the light to Osborne House, and they recommend that the wire be purchased. Mr. Steevens has agreed to pay £5 per cent. per annum on the cost of the wire until such time as the Council shall require it for other purposes."

Jude and West v. Walker and Watson.—At Liverpool some days ago, before Judge Bayliss, Q.C., and a common jury, this case was heard. The plaintiffs were Simon Jude and West, accountants, and the defendants were Malcolm Walker (sued as M. Walker and Co.) and Adam West Watson, and the action was brought to recover £250 damages for breach of contract in regard to an attempt to float on behalf of the defendants a limited company, to be called the Walker Electrical, Lighting, and Engineering Company, Limited. The defendant Walker pleaded that the transaction was a speculative one, and that the plaintiffs had failed to find directors as promised, and he paid £5 into court to cover plaintiffs' actual outlay. Defendant Watson denied being a party to any agreement. The jury found for the plaintiffs as against Walker for £5 beyond the sum paid into court, and that Watson was not liable. Judgment for the plaintiffs for the amount was then given, and also for Watson, with costs, his lordship remarking that the jury had arrived at a proper and sensible verdict.

Poryjcawl Lighting.—The Local Board, the other day, decided to light the streets with gas in preference to electric lighting.

Newcastle Gas Company and the Electric Light.—A communication has been received by the Newcastle Watch Committee from the Newcastle and Gateshead Gas Company, which states that owing to the partial adoption of the electric light by the Corporation, the special discount of five per cent. which it has been customary to allow the Corporation will, in future, not be allowed, and further, that the gas company intend to charge for the lamps up to March, which had been extinguished owing to the lighting of Grey Street and other places by the electric light. The company charge the Corporation a fixed rate per street lamp, but a number of the lamps have not been in use for a considerable time owing to the new light being adopted, and it is the intention of the company to charge for the lamps as though they had been used up to March. This will, of course, amount to a large sum, while the loss of the discount alone will come to £700 per year. It was decided to take the matter into consideration at a special meeting of the Watch Committee to-day.

Latimer Clark, Muirhead & Co., Limited.—On Thursday, in the Chancery Division of the High Court, before Mr. Justice Chitty, Mr. Kenyon Parker applied, on behalf of Mr. Chapham, in support of an application for the appointment of a receiver and manager in the matter of Latimer Clark, Muirhead & Co., Limited, electrical engineers. The applicant was stated to be one of the directors of the company, and the holder of a large number of debentures, the interest on which was now in arrears. The company, which carried on a large business, had now contracts in hand for the installation of the electric light in government offices; at Brighton, Richmond, and other places, and, as it was desirable that these contracts should be completed, the court was asked to sanction the borrowing by the receiver and manager of £4,000. There was no opposition, and his Lordship sanctioned the appointment of a receiver and manager, and gave leave to borrow the amount named.

Kingston Electric Lighting.—At a meeting of the Kingston Town Council, last week, several questions were asked concerning the arc lights in the public streets. It was stated that the work of lighting the streets was still in the hands of the contractors, Messrs. Siemens Brothers, and the committee would decline to take it over until the lighting was satisfactory, which they were assured would be about the end of the month. It was announced that during the previous five or six weeks about £150 had been received from consumers.

Ayrton and Mather's Electro-static Voltmeters.—During the past year these instruments, which we described last June, have been supplied by Mr. R. W. Paul, of 44, Hatton Garden, E.C., to the following electric lighting companies: the Metropolitan Electric Supply Company, the City of London Electric Lighting Company, the London Electric Supply Company, the Brush Company, the Laing, Wharton & Down Syndicate, besides the Bristol and Derby Corporations, and several foreign firms. Electro-static voltmeters for lower readings are being made on the same principle.

Windsor and the Electric Light.—At a recent meeting of the Town Council a letter was read from the manager of the Fowler-Waring Cables Company and Mr. A. A. Swinton, with reference to the electric lighting of Windsor, stating their intention to lay down a central station in Windsor with entirely new plant, and to apply to the Corporation for the sale or lease of land and water-power at the waterworks. The matter was referred to the Waterworks Committee.

Electric Light at Peterborough.—Messrs. Barford and Perkins have just put down an electric lighting plant in their engineering works. The lights at present fixed consist of a number of incandescent lamps of 16 candle-power in offices, and four arc lights each of 1,000 candle-power. Three of these are fixed in the fitting and erecting shops, while a fourth is raised on a pole 40 feet high in the centre of the yard, and effectively lights an area of about 20,000 square feet.

Mill Lighting. — Messrs. J. H. Holmes & Co. have installed 1,200 lights and generating plant at the mills of Messrs. Martin, Sons & Co., Lindley. A dynamo room has been built 48 feet long and 24 feet wide, capable of accommodating two large dynamos. At present, in addition to one small dynamo which runs the office circuit separately, there is only one large machine capable of supplying 1,500 lights, but it is intended to lay down another in due course.

Pulsford, Triquet & Co., Paris. — This firm have appointed Messrs. Barclay & Son, of 138, Regent Street, their sole agents for incandescent lamps in England. Messrs. Pulsford, Triquet & Co. are doing a large and increasing trade in France, and their lamps have only to become known in England to be highly appreciated. The ordinary stock sizes are sold to the public at 1s. 6d. each, and a liberal discount is allowed to the trade.

Messrs. Drake & Gorham.—As the result of the work which Mr. Drake designed and carried out for the Duke of Devonshire at Chatsworth, the Duchess of Montrose has placed in the hands of the firm the entire re-wiring and arranging of the whole of her installation at 45, Belgrave Square, after seeing what had been done at Chatsworth. There will be over 300 lamps.

Fleetwood Electric Lighting.—At a recent meeting of the Commissioners it was resolved that the correspondence forwarded to, and received from, the Brush Electric Company be received, and that the sum of £2,000 be inserted in the draft contract as security for the completion of the electric lighting works. It was also decided to engage a resident working electrical engineer.

Dublin Corporation Electric Lighting.—The Local Government Board have sanctioned a loan of £24,400 for the extension of electric lighting plant.

Ramsbottom and Electric Lighting.—The Electric Lighting Committee recently resolved, that having considered a scheme for supply of electric lighting for the district, and having regard to the necessity of obtaining provisional order of Local Government Board therefor, the matter be adjourned for further consideration, and in the meantime further information be sought.

Reduction in Price per Unit. — As will be seen in our City Notes, the Yorkshire House-to-House Electricity Company announces that it is about to reduce the price of its supply. From April 1st the price per Board of Trade unit will be 7d. when the consumption for the quarter does not exceed 1,000 units, and decrease in proportion to the quantity used, 6d. to be the rate when the consumption does not exceed 2,500 units.

Tunbridge Wells Electric Lighting.—The work of arranging the plant and buildings for the electric lighting of the chief centres of Tunbridge Wells is to be at once commenced, the Local Government having sanctioned the proposed expenditure of £13,000. In the event of the experiment proving a success, the scheme will in all probability be extended.

Bolton Electric Lighting.—In our issue for January 12th we stated that the tender of Mr. Wm. Crumblehulme had been conditionally accepted for lamp pillars. These pillars are for the gas lighting and not for electric lighting as would be inferred from our note.

Church Lighting.—St. John's (City) Church, Bristol, has been lighted by electricity. There are 52 lights. The work was carried out by the Brush Electrical and Engineering Company, Limited, under the supervision of Mr. J. E. Tongue, consulting engineer, of St. Stephen's Chambers.

New Branch.—The Eastern Telegraph Company have opened a branch station at 449, Strand, for the receipt and despatch of telegrams to India, China, Australasia, South America, Spain, Portugal, Greece, Turkey, and every part of the submarine telegraph system.

Aberdeen Electric Lighting.—A recommendation being made to the Town Council that two additional arc lamps be erected in Union Terrace, the matter was discussed, with the result that six lamps are to be erected instead of two.

Ventnor and Electric Lighting.—On the recommendation of the Works Committee, the clerk to the Local Board has been requested to obtain what information he can *re* electric lighting, and present his report to the next meeting of the Works Committee.

Bedford and the Electric Light.—The Board of Trade have decided that in their opinion the urban sanitary authority has not sufficient grounds for handing over the provisional order to the Bedford Electric Light Company.

Chester Electric Lighting.—A Town Council Committee last week reported that the placing of the central station in the Hop Pole Paddock would not do any damage to the Cathedral.

Hapton and Electric Lighting.—An electric lighting rate of 3d. in the £ has been issued for the lighting of the village for the present season.

CONTRACTS OPEN AND CLOSED.

OPEN.

Blyth (Northumberland).—February 7th. For the effectual lighting of the district for a term of years, for the Cowpen District Local Board (Blyth, Northumberland). Plans of the district can be seen at the office of the board, Commerical Buildings, Waterloo, Blyth, and particulars can be obtained from the board's surveyor.

Edinburgh.—For electric light installation in Chancelot Roller Flour Mills, Edinburgh. Specifications of the work required can be had by applying to the secretary, Scottish Co-operative Wholesale Society, Limited, 119, Paisley Road, Glasgow.

Great Yarmouth.—February 19th. For the construction, supply, and laying down of the necessary plant and mains for the supply of electricity in the borough, for the corporation, in accordance with specification, general conditions, plans, and form of tender which can be obtained at the office of Mr. J. W. Cockrill, A.R.I.B.A., borough surveyor, Municipal Buildings, Great Yarmouth. The person or firm whose tender is accepted will be required to enter into a contract and bond with two approved sureties for the due performance of the contract. Firms tendering may tender for the whole or any part of the plant. Any information concerning the specifications, &c., may be obtained from Mr. A. H. Preece, A.M.I.C.E., 39, Victoria Street, Westminster.

CLOSED.

Wolverhampton.—For erection of an electric lighting station in Commercial Road, for the corporation. The tender accepted was that of Mr. H. Willcock, Wolverhampton, £4,985.

Woking.—The tender of the Woking Electric Lighting Company has been accepted for the public lighting.

NOTES.

The Press and Quackery Advertisements. — The crusade against patent medicines and quack advertisements is spreading at a healthy rate. The partial suppression of the electric belt quackery may be considered the commencement of great things in this direction. A gigantic task has been accomplished in opening the eyes of the public to the necessity for being on the look-out for and avoiding cloaked impositions. Mr. Ernest Hart, in a well-prepared lecture on "The Responsibilities of English Journalism," delivered at Toynbee Hall, on Saturday last, dealt especially with patent medicines and quack advertisements. Such lectures should do a great amount of good to the public, while affecting the quacks in what, to them, is a very disagreeable manner. We take the following account of Mr. Hart's lecture from the columns of the *Times*:—

He said that everyone must recognise the ability with which the great papers treated questions of preventive medicine. The triumphs of medicine in the last half-century had been in the prevention of disease, for every man in that room had had three and a-half years added to his life within the last 20 years by the studies of medical men, and by the influence which the Press had exercised over the Government and the people in promoting general healthy conditions of life. But in the advertisement columns he saw day after day advertisements which were full of gross and unmistakable falsehoods, and were on the face of them attempts to exploit the public credulity. With certain exceptions, when the *British Medical Journal* had brought this fact to the notice of the leading editors, their answer was: "That is not our business; let the buyer take care of himself." Was that fair on the part of the newspapers? Half a century ago the quack used to go into the market-place in a handsome chariot with cream-coloured horses and a brass band. Nowadays, however, if a man wanted to sell a pennyworth of aloes for 10s., he hired some of the newspapers as his chariot. Some newspapers would not put in gambling or racing tips, nor would they insert any financial proposal which was on the face of it an impossible fraud. Why should the health of the people alone be the thing for which every scoundrel or pretender should have placed at his disposal the columns of nearly every newspaper in the country? He gave as an example a "skin tonic," which was sold at 11s. a bottle, and which, he averred, until recently, was composed of rather less than a half-pennyworth of corrosive sublimate. After referring to the various actions for libels begun but not persevered in by Mr. Harness, the lecturer said he wrote to the editors of all the newspapers on the subject of the "electric belt" advertisements, but the *Times* was the only paper that asked him for particulars, and subsequently refused to insert any more of the advertisements. The so-called religious papers were the worst offenders in the matter of quack and fraudulent advertisements. What he objected to was that quacks should have the power, under the Government stamp, which some people supposed gave a sort of guarantee of straightforwardness or value, to put forward statements palpably false. He thought that a great responsibility lay upon the Government which allowed this enormous traffic under conditions of *quasi*-sanction, or at least under conditions which facilitated fraud. The Government received £240,000 a year in three-halfpences from the sale of patent medicines. The word "patent" was in itself a falsehood. Before a man could get a patent he had to state what he wished to patent, and every one knew it, but the nature of the contents of these medicines was kept a secret, therefore they were not patent medicines. In conclusion, the newspapers should exercise the same supervision over the advertisement columns as they did over the editorial matter, and all medicines bearing the Government stamp should be required also to have a label stating their contents and composition. In replying to a vote of thanks, the lecturer said it required some courage for him to say what he had said, but he was fully prepared to defend it if the necessity should arise.

Tibbits v. Toye.—We are glad to be able to congratulate Mr. E. W. Toye, of the *Charity Record* upon the victory he last Saturday gained over Dr. Herbert Tibbits in this libel action. In the course of his evidence Dr. Tibbits stated that "he was a bankrupt in 1891, and was so when his action *versus* the Electrical Review was tried. Sir Richard Webster, Q.C., and three other counsel represented him. Mr. Harness did not find the money for that action. The Medical Battery Company did in one sense. Harness was only their manager. His action was for libel, and the verdict was for the defendants. The alleged libel was with regard to a testimonial he had given the Harness belts. He was paid 100 guineas, but not for writing the testimonial. He had had six weeks' hard study in the matter. He had actions for libel pending against the *Morning* newspaper, and against Messrs. Mercer, Boxall & Dowell. This action had cost him only £2 10s. He would pay his solicitor if he had money to do so. All the money he had now was 3s. 6d., but he might have more to-morrow if a distinguished patient turned up. (Laughter.) He had no one behind him in this case."

Employer's Liability.—In September last, while the electric lighting buildings were being erected at Stafford, the scaffolding broke down, owing to the bad quality of the timber used, and a workman was injured. He has just obtained £40 damages and costs from the contractor.

Obituary.—Captain Robert Halpin died on Saturday last at his residence, Tinnakelly, Wicklow, from blood poisoning. He was the Unionist candidate for Wicklow at the last Parliamentary election. During the laying of the 1865 and 1866 Atlantic cables Captain Halpin served on board the ss. *Great Eastern* under the late Sir James Anderson, and afterwards succeeded to the command of this leviathan. On the retirement of Sir Samuel Canning from the post of Engineer-in-Chief to the Telegraph Construction and Maintenance Company, Captain Halpin took charge of several successful cable expeditions on behalf of this company. He was a genial man, and will be missed by many friends.

H. Newman Lawrence Testimonial.—We have received a copy of a circular issued by Mr. Ed. C. de Segundo and Mr. Thomas Adams, who are the joint secretaries connected with the movement which has been placed on foot to raise a fund for the purpose of relieving Mr. Newman Lawrence of his embarrassments. This circular states that Mr. Lawrence's present circumstances are chiefly attributable to the disrepute into which electro-medical treatment has gradually fallen in the estimation of the public, "through the practices of those with whom he has been in no way connected." The committee that has been formed to manage the movement is very influential, including Viscount Templetown, Mr. W. H. Preece, and Profs. Ayrton, Silvanus P. Thompson, Victor Horsley, R. M. Walmesley, and W. E. Sumpner, in addition to a number of other gentlemen. We extract the following paragraphs from the circular, from which an idea of the committee's intentions may be gained:—"During the whole of his professional career, Mr. Lawrence has steadfastly sought to raise electro-therapeutics to its proper position as a science, and his various communications to the British Association, the Institute of Electrical Engineers, the Society of Arts, &c., are recognised as useful contributions to scientific literature; while the various books and pamphlets of which he was author, or joint author, have met with most favourable review. His electrical knowledge has been recognised by his having been elected a member of the Institution of Electrical Engineers, and his assistance to therapeutics by the American Electro-Therapeutic Association having made him a Fellow. . . . . It is a curious instance of the irony of fate that Mr. Lawrence should have been conducive in turning the tide of public opinion to such an extent as to bring about so strong a reaction from blind credulity to utter disbelief in the curative properties of electricity, that the committee understand there is little or no electro-therapeutic work of any kind now being carried on outside the hospitals. The above circumstances, which have come to the knowledge of the members of the committee whose names appear above, seem to them to constitute a case in which they can confidently appeal to their professional brethren, both electrical and medical. They consider that a suitable testimonial would not only be of great service to the recipient, but that it would be both well deserved and worthily bestowed. They have ascertained that Mr. Lawrence has an opportunity of making his way in the United States, and they propose that the funds that may be raised as a result of this appeal, should be devoted to furthering this object. They sincerely trust that these funds may be amply sufficient to enable them to provide the necessary passage, outfit, and incidental expenses, and also to support Mr. Lawrence's wife and family in England until he is in a position to send for them. Members of the Old Students' Association of the City and Guilds of London Institute are reminded that Mr. Lawrence was the founder and first President of that Society. . . . . Subscriptions will be received by Mr. De Segundo, at 28, Victoria Street, S.W., and Mr. Adams, 24, Hillfield Road, West Hampstead, N.W., or they may be paid into the 'Lawrence Testimonial' account at Messrs. Lloyd's Bank, Limited, 54, St. James's Street, London, S.W." Mr. Newman Lawrence's articles on electro-therapeutics, published in these columns, will be remembered by our readers, some of whom may possibly be disposed to assist him.

Correspondence.—We have received several letters from correspondents, but regret we are compelled to hold them over until next week, owing to pressure of space. One of these is from Messrs. G. E. Belliss & Co. on "Double-acting *v.* Single-acting Engines;" another is from Prof. Elihu Thomson on "Keely Reminiscences."

Claim for False Imprisonment in the Harness Case.—Dudley Towers has served Colonel Brasyer, C.B., with a writ claiming £1,000 damages for false arrest and imprisonment in connection with the Harness prosecution. Mr. Burbage, of Liphook, another of the prosecutors, is also being sued by Towers.

Newport Tenders.—On the subject of the letter published among our "Notes" last week, Messrs Willans and Robinson have written further to the *South Wales Star*, as follows:—"Referring to our letter which appeared in your columns last week we find, on again reading Mr. Siemens's address, that the figures quoted by us (53,300 horse-power) as the total horse-power of lighting stations at work or under construction applied only to stations belonging only to municipalities, and that for *all* the lighting stations the figure is 88,000. We are not, therefore, in the position, as we stated, of having received orders for about *three-quarters* of the entire horse-power for public lighting stations in the United Kingdom, but for about *half*. We do not gather, however, that the whole of the 88,000 horse-power has been actually ordered, though doubtless specified, or even advertised for, and we believe we may safely claim that the engines supplied by us, or ordered from us, for public electric lighting stations in England, are at least equal to, and probably surpass, in horse-power, the engines supplied or ordered for the same purpose from all the other engine builders of the United Kingdom together. The matter is not very important, but we should not like an over-statement of our case, however inadvertent, to remain uncorrected. You will probably agree that whether the proportion is one-half or three-quarters, our tender for the direct driving plant should scarcely have been ignored altogether, while our charge that the system of driving the large machines by ropes is obsolete and inefficient, is supported not only by our practice, but by that of every other maker who has made a speciality of electric light engines."

The Northern Society of Electrical Engineers.—This society is an accomplished fact. The members have met and dined, this memorable event taking place at the Palatine Hotel, Manchester, on the 22nd inst. Mr. G. E. Preece, of Manchester, told the company that 100 gentlemen had been enrolled as members, 50 residents of Manchester and 50 "provincials," the latter, of course, including the Londoners. Convenient offices, adjacent to the hotel and communicating therewith by a private staircase, have been acquired, and a banking account has been opened. The President, Vice-Presidents, and Council have all been duly elected, and although the general rules and regulations of the London I.E.E. are good enough for the Northern S.E.E. to take as a model, yet in the matter of re-electing their governing body they will keep clear of the bad ways into which the London Institution has fallen. Mr. Browett gave the health of the Council, which was acknowledged in eloquent speeches by Mr. Fawcus and Dr. Edward Hopkinson. The "London Provincials" were represented by Mr. Ferranti and Mr. Manville. The former gentleman gave the members of the new society well meant advice, with his usual force and eloquence. He told them that the electric light industry would be benefited if pressure were higher and the cost lower. He frankly confessed that it was his belief that speeches and papers read at similar society meetings were mostly cheap self-advertisements, a fact of which he by no means disapproves as long as people are honest enough to acknowledge it. Mr. Harry Edmunds duly advised upon competition and cutting prices, and his exhortation, "Don't let us live upon each other, let us live on the public," was duly appreciated by the Lancashire mind. Songs were given by members, and harmony reigned supreme, in spite of some *Marr*-ing sounds and a bad piano. We feel confident, considering the well known Lancashire energy, shrewdness and good appetite, that the Northern S.E.E. will be successful in its aims to promote electrical science, commercial prosperity and social intercourse.

Lectures.—On Tuesday next, January 30th, a lecture on "Electricity: Its Nature, Effects, and Use to Mankind," is to be delivered by William H. Marshall before the St. Luke's Young Men's Christian Union, West Holloway.

Tunbridge Wells Electric Lighting.—The Local Government Board has sanctioned the borrowing of £13,000 for public electric lighting purposes.

Taunton Manager Sentenced.—Henry E. Hunt, the manager of the electric light works at Taunton, who was charged with defrauding the corporation of about £280, has been sentenced to 12 calendar months' imprisonment with hard labour.

The Royal Society.—Before this society yesterday, the following paper was down for reading:—"The Effect produced upon Respiration by Faradic Excitation of the Cerebrum in the Monkey, Dog, Cat and Rabbit," by Dr. W. G. Spencer.

The Recent Explosions.—At the last meeting of the Commission of Sewers, a report was read from Mr. W. H. Preece on the subject of the recent explosions on Ludgate Hill in two boxes used for the purpose of electric lighting. Mr. Preece stated that the explosions were due to a collection of coal gas and air in the boxes, but the cause of ignition was not apparent. Since the occurrence the electric lighting company had introduced a system of inspection of such boxes, so as to prevent a collection of gas from leaky mains in those apartments.

Test of Siemens-Willans Set.—We venture to think that the figures below are of some interest, as to the best of our knowledge so high an efficiency as 88 per cent. has not been previously obtained. The tests were carried out at the works of Messrs. Willans & Robinson, under the superintendence of Prof. Kennedy, the consulting engineer. The set is for the Glasgow Corporation:—

Siemens Dynamo, H B 27/40 Shunt-Wound, No. 3,053.—Willans Engine, I I I, Central Valve Compound, No. 1,533.

Load.	Pressure in steam pressure.	Revolutions per minute.	Amps.	Volts.	I.H.P.	E.H.P.	Water lbs per E.H.P.	Efficiency per cent.
Full	139	346	1,001	225	343	302	23·8	88·04
¾	112	347	740	225	262·2	223·2	27·1	85·11
½	88	344	515	225	197·2	155·3	31·63	78·76
¼	56	345	236	225	112·2	71·2	47·9	63·44

Cost of Electrical Energy.—The first meeting of the Liverpool Engineering Society for the year 1894 was held on 17th inst. A paper on "The Supply of Electrical Energy: Its Cost and Price," was read by Mr. A. B. Holmes. Mr. Holmes recorded the progress made since 1890 by the Liverpool Electric Supply Company. Since that date the length of street mains had been increased from 20 to 30 miles, and the number of lamps supplied from 12,000 to £25,000. The items which formed the cost of production were dealt with *seriatim*, and attention was drawn to directions in which, with an increased output, economies in working may be attained. The load on a station supplying electricity for lighting purposes was shown to be extremely variable, the maximum load in winter being 100 times greater than the minimum load in summer, the cost of working the plant being much greater in consequence than would be the case were it possible to run the plant under uniform load. It was pointed out that great advantage would be derived from any practicable method of storage, but that the high cost of accumulators at present prevented their commercial use for that purpose. Various methods of charging for the supply of energy were described and compared. It was stated that at the price charged for electricity in Liverpool, the cost of lighting by incandescent lamps was approximately double that of gas.

Preservation of Timber by Electrolysis.—The impregnation of timber can, it is said, be very quickly and expeditiously carried out by the aid of electricity. The apparatus comprises, says the *Moniteur Industriel*, two boilers for the preservative liquid to be injected, a circulating pump and its motor, a steam boiler and a dynamo. The saline liquid is heated in the usual manner by means of a current of steam. At the same time an electric current is passed through the impregnating boiler. The combined action of the electric current and the heat causes the timber to be thoroughly impregnated in one hour, while the usual process with heat, but without the electric current, takes from 10 to 40 hours.

Prize Offered for 1894.—The Netherland Society for the Promotion of Industry invites papers containing an indication of the means to obtain energy through windmills, to accumulate this energy electrically, to transmit it or to make it transportable; and desires more particularly an answer to the following questions:—(1.) What is the average energy a common windmill is able to produce per day of 24 hours, in combination with an electric accumulator; what would be the installation most suitable to this effect, and what would be the cost of *one* horse-power hour? (2.) Is it possible, from an economical point of view, to apply the new aerial motors on an extensive scale for the accumulation and the utilisation of this energy? If so, what mechanical appliances would be required for this purpose? The project of a supposed application of the system, by which a factory is provided with light and power, is wanted as an illustration. The drawings belonging to the answers must be made on white paper (no blue prints) on a scale of $\frac{1}{4}$. The prize offered is the gold medal of the Society and a reward of £30 —$140). Answers must be sent before July 1st, 1894, with the author's name in a closed envelope, to the General Secretary of the Society, F. W. Van Eeden, at Haarlem, Holland. Further information about the conditions may be obtained at the same address.

NEW COMPANY REGISTERED.

The Electric Exploitation Company, Limited (40,256).—This company was registered on the 4th inst. with a capital of £25,000 in £1 shares, to carry on business as an electric light and power supply company, and electric and mechanical engineers, and to acquire any patents that may be of use to the company. The subscribers (with one share each) are:—A. H. Treadwen, Hampton Wick, gentleman; H. T. Godrick, 125, Tottenham Court Road, gentleman; E. J. D. Hewitt, 19, Queen Victoria Street, E.C., secretary; W. Wood, 52, Devonshire Street, W., gentleman; J. A. Buchanan, 41, Colville Gardens, W., gentleman; V. C. Doubleday, 37, Walbrook, E.C., accountant; P. C. Atkins, 34, Walbrook, E.C., solicitor. The number of directors is not to be more than five nor less than two. The first are, V. C. Doubleday and J. A. Buchanan. Qualification, £100. Remuneration to be decided in general meeting. Registered by Hyland & Atkins, 34, Walbrook, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Railway Automatic Electric Light Syndicate, Limited.—The annual return of this undertaking was filed at Somerset House on the 9th inst., and shows that out of a nominal capital of £25,000, in 400 ordinary and 600 preference shares, all of £25 each, 520 of the latter, and 396 of the former, have been taken up. Sums of £25 on each of 198 ordinary, £15 on 484 preference, £10 on 30 preference, and £5 on six preference shares have been paid. As much as £11,550 has been remitted; £5,000 has been considered as paid, £985 is outstanding, and £45 is the amount on four shares forfeited.

United States Power Syndicate, Limited.—The last return of this concern, made on November 17th, 1893, shows that out of a nominal capital of £70,000, in 2,000 preference and 5,000 ordinary shares, all of £10 each, 390 preference and 3,500 ordinary shares have been taken up; £2 10s. has been called on each of the preference, and the full amount on each of the ordinary shares. The total remitted is £20,975, together with £150 paid in advance of calls, and £15,000 has been considered as paid.

Crompton & Co., Limited.—The lately filed yearly return of this company states that out of a nominal capital of £300,000, in 30,000 preference and 30,000 ordinary shares of £5 each, 28,080 preference and 9,928 ordinary shares have been taken up. The full amount has been called on the preference shares, and £1 on each of 1,928 ordinary. A sum of £142,085 has been received in response to calls; £40,000 has been agreed to be considered as paid, and there is still £243 in arrear.

Dan Rylands, Limited.—The last return of this company, bearing date December, 12th, 1893, shows that out of a nominal capital of £275,000, in £5 shares (20,000 ordinary and 35,000 preference), 16,617 ordinary and 25,965 preference shares have been taken up. There has been £5 called on each of 12,617 ordinary and 23,985 preference shares; £183,010 has been remitted, and £29,900 has been agreed to be considered as paid.

Venezuela Telephone and Electrical Appliances Company, Limited.—The last return of this company, dated December 15th, 1893, shows that the whole of a capital of £70,000, in £1 shares, has been taken up. There has been £1 called and paid on each of 13,494 shares, and £56,506 has been considered as paid.

Sheffield Electric Light and Power Company, Limited.—The last return of this company shows that out of a capital of £98,000, in 14,000 £7 shares, 4,000 shares have been taken up, with £1 paid on each. A sum of £3,995 has been remitted; £20,000 has been agreed to be considered as paid, and £5 is now outstanding.

British Electro-Chemical Agency, Limited.—This company's last return states that out of a nominal capital of £75,000, in £10 shares, 5,000 shares have been taken up, with £2 paid on each of 2,500. A total sum of £4,645 has been remitted; £25,000 has been agreed to be considered as paid, and £355 is still outstanding.

Queen Anne's Mansions Lighting and Heating Company, Limited.—The annual return of this company, filed on the 3rd inst., shows that out of a nominal capital of £60,000, in 3,000 preference and 3,000 ordinary shares of £10 each, the whole of the shares have been taken up, and the amount has been agreed to be considered as paid.

Universal Arc Lamp Syndicate, Limited.—This syndicate's latest return shows that out of a nominal capital of £3,000, in £1 shares, 2,865 shares have been taken up. A sum of 1s. 6d. has been called on each of these; but the full amount has been paid on 15 shares, and £228 15s. is the total received.

Salt Lake and Ogden Gas and Electric Light Company, Limited.—The statutory return of this company shows that out of a nominal capital of £300,000, in £1 shares, merely the seven subscribers shares have been taken up.

Rugby School Electric Lighting Company, Limited.—The statutory return of this concern says that out of a nominal capital of £5,500, in £50 shares, 70 shares have been taken up. A sum of £25 has been called on each share, and £1,750 has been received in response to calls.

County of London Electric Lighting Company, Limited.—The name of this company has been changed to the County of London and Brush Provincial Electric Lighting Company, Limited.

Woodfield Syndicate, Limited.—This company's last annual return shows that the whole of the capital of £12,000, in £1 shares (10,000 "A," 1,000 "B," and 1,000 "C"), has been taken up, and paid in full.

English Electric Manufacturing Company, Limited.—The registered office of this company is now at 30, Stamford Street, Leicester.

Telegraph Improvement Company, Limited.—The last annual return of this company shows that out of a nominal capital of £100,000, in £1 shares, 15,006 shares have been taken up. A sum of £1 has been called on each of six shares, and £15,000 has been agreed to be considered as paid.

Williamson Electrical and Engineering Company, Limited (In Liquidation).—The registered office of this company is now situated at Temple Chambers, 29, Brazennose Street, Manchester.

Universal Arc Lamp Syndicate, Limited. — The registered office of this company is now at 4, Arthur Street, New Oxford Street, W.C.

CITY NOTES.

ELECTRICAL concerns have worn quite a bright aspect in the Money Market during the past few days. Generally speaking, sound companies have shown a tendency to rise in the opinion of investors, electrical manufacturing and supply companies shares especially securing buyers at good prices. Our contemporary, the *Financial Times*, was struck with the good tone of electrical securities, and gave on Tuesday the following table:—

Stock.	Price, January 2nd.	Price, January 22nd.	Rise.
Brush	2⅜ — 2⅝	2⅝ — 2⅞	¼
City of London	11¼—11⅜	11¼—11⅜	...
St. James's and Pall Mall..	5½ — 6	6 — 6½	½
Do. Preference ...	7⅞ — 8¼	8 — 8½	¼
Westminster Supply ...	5 — 5½	5¼ — 5⅝	¼
Metropolitan Supply ...	7⅞ — 8¼	8¼ — 8⅝	½
Do. Debentures ...	103 — 6	104 — 8	1½

The most noticeable rise is that of St. James's and Pall Mall, though it is difficult to account for, in face of the 1893 report. However, we have dealt with this company's accounts in detail elsewhere.

THE Anglo-American Company accounts, when compared with the corresponding period of the previous year, show a decrease in receipts of £8,493. The total is £151,095, but it is subject to revision, as the law suit between this company and the Paris and New York Telegraph Company is still pending. This saving clause has appeared in the last half-dozen reports, and there is nothing to show that it will not appear in six more. Although a cable company may suffer from a falling off in receipts, the expenses are practically stationary. The cost of administration, including repair of cables, amounted to £59,250, which is an increase of £622. Repairs of cables swallow up about £30,000, but £17,000 of this is paid out of the renewal fund. There is, unfortunately, nothing to show for this outlay, the expedition which cost this sum being a complete failure. The directors have apparently come to the conclusion, and not hurriedly, that repairs of cables are becoming an expensive matter, and it has been resolved to lay a new cable between Valentia, Ireland, and Heart's Content, Newfoundland, which is to cost £450,000. This will reduce the reserve fund materially, and the directors ought not to overlook this fact. The total distribution for the year to the shareholders is £2 11s. per cent. on the ordinary stock, and £5 2s. per cent. on the preferred stock.

We have been recently looking over the reports of the company for the past three years, and find that the fluctuations in the total receipts are most striking, as will be seen from the following table:—

	Total Receipts.	Increase.	Decrease.	Expenditure.
	£	£	£	£
1890 (January to June) ...	152,989	2,025	...	53,945
1890 (July to December) ...	161,986	3,027	...	56,142
1891 (January to June) ...	139,184	...	8,432	54,657
1891 (July to December) ...	164,121	6,157	...	63,507
1892 (January to June) ...	147,818	10,035	...	59,364
1892 (July to December) ...	164,365	...	4,670	58,628
1893 (January to June) ...	148,185	367	...	60,182
1893 (July to December) ...	151,095	...	8,493	59,252

Of the eight foregoing reports, repairs to the Brest-Pierre cable are spoken of in six. This cable has probably been more trouble than all the rest.

THE City and South London Railway Company's report is, perhaps, not quite so satisfactory as the last, though, under the circumstances, shareholders cannot grumble:—

The receipts from all sources for the past half-year have amounted to £22,821 7s. 9d., and the cost of working has been £14,761 11s. 3d., leaving a profit of £8,059 16s. 6d. Inclusive of the balance brought forward from June 30th last, the net revenue account shows an aggregate total of £8,927 10s. 7d. After making provision for the debenture and debenture stock interest, a balance remains available for dividend of £4,792 8s. 10d. Out of this sum the directors recommend the full dividend of 5 per cent. per annum to be paid on the preference shares, and that a dividend at the rate of ⅝ per cent. per annum be paid upon the consolidated ordinary stock, leaving a balance of £1,063 13s. 10d. to be carried forward to the next account. The following table shows the number of passengers, exclusive of season ticket holders, carried since the opening of the railway in each half-year:—

Half-year.	Number of passengers.	Receipts (including season tickets).
		£ s. d.
Ended December 31st, 1890 (11 days) ..	165,000	1,568 3 9
„ June 30th, 1891	2,412,343	19,403 6 9
„ December 31st, 1891	2,749,055	19,798 16 6
„ June 30th, 1892	2,813,162	20,931 4 2
„ December 31st, 1892	3,117,602	22,002 17 5
„ June 30th, 1893	3,146,656	22,458 6 9
„ December 31st, 1893	3,093,351	22,067 14 10
Total since the opening of the line	17,497,169	£128,230 10 2

In the course of the half-year £32,200 of the terminable 5 per cent. mortgage debenture bonds have been paid off, and are being re-issued as 4 per cent. perpetual debenture stock.

The directors say that the falling off in traffic is due to the extremely fine weather of last summer, and to the fact that the football matches have not been played on the Oval this winter. Probably they will suffer from neither of these causes during 1894; we hope for the best.

We wish something more had been said in the report about the extension to Islington, for we believe this will be the salvation of the company. It has always seemed to us that the present line would never be able to pay fair profits, and though there will be a great outlay on the new line, it ought to prove remunerative enough to provide a good return on the whole undertaking. Mr. Grey Mott is habitually cautious, but it is to be hoped that at the general meeting he will take the shareholders into his confidence, and say what he thinks about the prospects of the Islington extension.

THE Yorkshire House-to-House Company announce considerable reductions in the price of current. Commencing on April 1st next, the price per Board of Trade unit will be as follows:—When the consumption for the quarter does not exceed 1,000 units, 7d.; when the consumption for the quarter exceeds 1,000, and does not exceed 1,500 units, 6¾d.; when the consumption for the quarter exceeds 1,500, and does not exceed 2,000 units, 6½d.; when the consumption for the quarter exceeds 2,000, and does not exceed 2,500 units, 6¼d.; when the consumption for the quarter exceeds 2,500 units, 6d. These prices will be subject to discount based upon the number of hours per quarter during which the current is used, each consumer being called upon to declare the maximum number of lights required to be in use at any one time. The scale of discount is as follows:—For not less than 200 hours' use (in the quarter) of the maximum supply demanded, 5 per cent.; for not less than 300 hours' use (in the quarter) of the maximum supply demanded, 10 per cent.; for not less than 450 hours' use (in the quarter) of the maximum supply demanded, 15 per cent.; for not less than 600 hours' use (in the quarter) of the maximum supply demanded, 20 per cent. In addition to the discounts accruing under the above table, a discount of 5 per cent. will be allowed on the net amount of accounts paid within one month from the date of rendering, and 2½ per cent. on accounts paid within two months. We are glad to hear that it has been found necessary to make extensions. If they are economically done, and there is no reason why they should not be, this company ought shortly to be in a very good position.

THE accounts of the St. James's and Pall Mall Company, when compared with those of previous years, are very unsatisfactory. The management are in no way responsible for this; the events which have happened during the past year could not have been avoided. There have been many difficulties to contend with, and we can quite understand that the year through which they have passed has been one which has given them much extra work and considerable anxiety. The company has had to put up with adverse legal decisions, reckless competition, and a large falling away of revenue. The accounts are not in themselves bad, but the company has hitherto been able to show such magnificent balance-sheets, that one naturally measures the results by a high standard. We fully expected the legal charges during 1893 to be much higher than £1,528; this has not appreciably affected the expenses, which are about the same as last year. The shrinkage in the receipts for sale of current is the most alarming item in the report. Compared with last year, they show a decrease of over £4,000. This is most lamentable, for it must be pointed out that the Carnaby Street station has been supplying current for the past 12 months. The following comparisons of the past three years will show the remarkable decrease in the sums received from sales of current:—

1891	...	£30,934	... One station.
1892	...	£33,941	... One station.
1893	...	£29,766	... Two stations.

The expenses for the three years have scarcely varied, though we believe the cost of producing a unit of current was less last year than it has hitherto been. The result is that the net earnings of the company during the past year have amounted to £10,552, which compares badly with the £14,598 of the previous year. The ordinary shareholder, instead of receiving the generous dividends of former years, must remain content with 4½ per cent.

The directors say competition with other companies is the cause of this great decrease. No doubt a reduction all round of a penny per unit would make a great difference in the returns. Still, the increased number of consumers which the company states has been secured, ought to have nullified this. It seems to us that the whole trouble of the company has come from the new district round Carnaby Street; they had practically a close borough in the St. James's district, but they were compelled, by the terms of their provisional order, to erect a second station, and meeting with competition, they have sustained a temporary check. We say temporary, for we have great faith in the economical working of this company placing it in its former opulent position. The expenditure for the year is £25,699; the total expenditure up to date reaching £211,029. The capital has not been increased beyond the £200,000, but debentures will probably be issued during this year.

We give below a few extracts from the accounts, but up to the time of going to press, we had not received figures which would enable us to give the cost of working. Probably we shall deal with the costs next week.

REVENUE ACCOUNT.

DR.	£	s.	d.
Cost of Generating.			
To Coals and other fuel, including dues, carriage, &c.	4,379	16	3
„ Oil, waste, water and engine room stores	701	9	2
„ Salaries of engineers and officers	990	9	0
„ Wages at generating and distributing stations ...	2,953	13	5
„ Repairs and maintenance:—Buildings; engines and boilers; dynamos; other machinery, instruments and tools; accumulators; lamps (at stations)	1,071	13	11
„ Repairs and maintenance of mains	885	12	10
„ Renewals:—Engines; mains	1,290	19	11
„ Miscellaneous expenses	63	13	6
„ *Rents, Rates and Taxes*	1,081	6	8
Management Expenses.			
„ Directors' remuneration; salaries of general manager and secretary, engineer, clerks, canvasser, &c.; stationery, printing and advertising; general establishment charges; auditors of company...	3,695	8	0
Law Expenses.			
„ Law expenses (including provision for costs in the founders shareholders' action)	1,528	1	1
Special Charges.			
„ Insurance; expenses (other than law charges) in abating nuisances; fees for testing meters; Board of Trade audit	545	14	6
Depreciation.			
„ Depreciation on buildings ... £668 19 9			
„ „ „ plant, machinery, &c. 1,292 4 4			
	1,961	4	1
	21,149	2	4
„ Balance carried to net revenue account	9,910	6	8
	£31,059	9	0

CR.	£	s.	d.
By Sale of current, after deducting provision for bad and doubtful debts	29,389	5	5
„ Ditto under contract...	377	5	4
„ Rental of meters on consumers' premises	698	11	10
„ Rents receivable	466	11	5
„ Transfer fees	41	10	0
„ Discounts on purchases	70	11	5
„ Sale of old materials, stores, &c.	13	12	1
„ Sundry fees, shareholders' lists sold, &c.	2	1	6
	£31,059	9	0

GENERAL BALANCE SHEET, December 31st, 1893.

DR.	£	s.	d.
To Capital account—			
Amount received as per account No. III. ...	200,000	0	0
„ Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, &c. ...	2,510	3	9
„ Sundry creditors on open accounts...	1,892	16	4
„ Lloyd's Bank, Limited, temporary loan	15,000	0	0
„ Unclaimed dividends	5	7	1
„ Capital reserve fund	15,000	0	0
„ Net revenue account—			
Balance at credit thereof ... £10,615 18 9			
Less interim dividend paid on preference shares 3,500 0 0			
£7,115 18 9			
Add undivided part of the redemption fund, belonging to ordinary shareholders, see paragraph 3 of directors' report 1,000 0 0			
(For proposed division, see paragraph 11 of directors' report)	8,115	18	9
	£242,524	5	11

CR.	£	s.	d.
By Capital account—			
Amount expended for works, less depreciation to date, as per account No. III.	211,029	4	1
„ Stores on hand—			
Coal £108 12 0			
Lamps 16 13 4			
Meters and switches 768 15 10			
General, including oil, waste, &c. 976 17 4			
	1,870	18	6
„ Sundry tenders for current supplied 9,091 0 10			
„ Other debtors... ... ... 907 13 10			
	9,998	14	8
„ Cash at bankers (Lloyds Bank, Limited) 2,515 17 2			
„ Cash in hand 22 4 8			
„ Bank of England stock at cost ... 2,087 6 10			
	4,625	8	8
„ Capital reserve fund investments, Canada 3 per cent., Cape 3½ per cent., and India 3 per cent. stock, being in substitution of the 2½ per cent. annuities as per last account	15,000	0	0
	£242,524	5	11

Crompton & Co., Limited.

THE shareholders in this company will on Tuesday next (30th inst.) be asked to give the directors power to issue £100,000 of first mortgage 4½ per cent. debentures. This issue is necessitated by the want of working capital, which the directors say is essential for the development of the company's business. Another object of the present issue is to consolidate the loans from their bankers into one security. The existing £50,000 of 5 per cent. debentures will have to be redeemed to enable the directors to effect the issue. The new debentures will be redeemable at the option of the company after five years from date of issue at £101 per £100 bond, and £50 10s. per £50 bond. The directors, in circularising the shareholders, make a few remarks regarding the company's position. The profits during the six months ended September 30th last, notwithstanding the serious depression of trade, were sufficient to justify the directors in declaring an interim dividend; "but," says the circular, "owing to the necessities of the business in carrying out the various large contracts in hand, the directors have hesitated about doing this until the arrangements for further capital, by the present issue of debentures, are completed." It seems that the directors have had some proposals made to them by persons desirous of taking up the bonds, but the shareholders are receiving the first offer. The resolution shareholders will be asked to agree to at the meeting on Tuesday, which is to be held at 3 o'clock, at Cannon Street Hotel, is as follows:—"That the directors be, and they are hereby, authorised to borrow any sum or sums of money on such security and upon such terms, as to interest or otherwise, they may deem fit, provided that the amount borrowed shall not exceed in the whole, without the further sanction of a general meeting of the company, the sum of £100,000."

Eastern Telegraph Company, Limited.

THE directors' report for the half-year ended September 30th, 1893, presented to the forty-third half-yearly ordinary general meeting, held at Winchester House yesterday, states that the revenue for the period amounted to £369,967 5s. 1d., from which are deducted £98,106 8s. 10d. for the ordinary expenses and £31,906 4s. 3d. for expenditure relating to repairs and renewals of cables, &c., during the half-year. After providing £6,753 16s. for income tax, there remains a balance of £233,200 16s., to which is added £1,133 8s. 10d. brought from the preceding half-year, making a total available balance of £234,334 4s. 10d. From this balance there have been paid:—

	£	s.	d.
Interest on debentures and debenture stock	37,696	18	0
Dividend on preference shares	20,384	12	11
Two interim dividends of 2s. 6d. per share each on the ordinary shares	100,000	0	0
	£148,081	10	11

Leaving a balance of £86,252 13s. 11d., which is carried forward to the next account. The revenue includes £22,373 7s. 4d., dividends for the half-year upon the company's shares in the Eastern and South African, the Black Sea, the Direct Spanish, and the African Direct Telegraph Companies. Under the terms of a contract dated June 17th, 1893, with the Portuguese Government, the Brazilian Submarine Telegraph Company and this company have secured an additional 10 years of their respective privileges under existing Portuguese concessions. To obtain this extension, this company and the Brazilian Submarine Telegraph Company undertook to connect Lisbon and this company's general system with the Islands of the Azores, and the two companies hold a large proportion of the shares in the Europe and Azores Telegraph Company which has been formed to work the line. The new cable was laid in August last. Since the last general meeting a cable has been laid from Zanzibar to Seychelles and Mauritius, under agreement with Her Majesty's Government and the Eastern and South African Telegraph Company, thus connecting these colonies with the company's system of submarine telegraphs. In accordance with the provisions of the articles of association, two of the directors, Sir John Pender, G.C.M.G., M.P., and Charles W. Stronge, Esq., C.B., retire by rotation at this meeting, and, being eligible, offer themselves for re-election. The retiring auditor, Mr. Henry Dever, desires to offer his firm, Messrs. Deloitte, Dever, Griffiths & Co., for election as auditors to the company. Messrs. Welton, Jones & Co. also retire, and offer themselves for re-election.

Sir John Pender presided over the meeting of this company held yesterday. He went in detail through the accounts, and pointed out the great increase of traffic with the Cape and India. There was a considerable decrease in the working expenses of the stations. The principal increase was in the salaries and wages of the staff. Improvements had been effected at the Alexandria station. They received considerable sums for the hire of cable ships. He thought shareholders would be satisfied that economies had been effected. The total amount of the reserve fund now stood at £1,290,000. They had duplicated and triplicated most of their lines, and he considered that the company was now in a stronger position than it had even been before. He was going to ask as extra remuneration for the management the rather modest amount of £300. They had secured a continuation of the valuable right at Lisbon. He then referred to new working arrangements with the South African Company. They were making considerable changes in the Levant, which would result in a saving to the company. He dwelt at some length upon the strong position of the company, which was shown by the good opinion of investors. Although they were very strong they still had their difficulty, the question of exchange was a very serious one for them occasionally, but they had been able to meet in a satisfactory manner. After further remarks he proposed the adoption of the report, which was agreed to.

The re-election of directors and auditors concluded the business of the meeting.

Direct United States Cable Company, Limited.

THIS company held its twenty-third ordinary general meeting on Tuesday last at Winchester, under the able presidency of Sir John Pender. One of the many good things to be said about Sir John is, that he never fails to avail himself of the opportunity of addressing at the periodical gatherings the shareholders in the many companies of which he is the chairman.

The usual opening formalities having been disposed of by Mr. FINNIS (secretary),

The CHAIRMAN moved the adoption of the report and accounts. The revenue for the half-year, he stated, after deducting the outpayments, amounted to £41,052, and the working and other expenses, including income tax, to £19,060, leaving a balance of £21,992 as the net profit of the half-year, making, with £819 brought forward from the previous half-year, a total of £22,811, which has been appropriated as follows:—Interim dividend of 3s. 6d. per share for quarter ended September 30th last, £10,624 5s.; interim dividend of 3s. per share for quarter ended December 31st last, £9,106 16s.; balance carried forward, £3,080 10s. 10d. The revenue, as compared with that of the corresponding period of 1892, showed a falling off of £2,577, owing to the severe commercial depression which had prevailed, and to the interruption of several of the Atlantic cables, particularly of the cable between Brest and St. Pierre. The expenses in London remained practically unaltered. They were on the whole within £72 of the amount in the same period of 1892. Expenses at stations showed an increase of £38 for the six months. There was an increase of £80 in income tax, due to the higher rate of assessment. Unlike railways and many other companies, the cables company were bound not only to keep the whole of its through system in full and continuous running order, but to keep it fully and efficiently managed, whether business were brisk or slack, consequently the ordinary expenditure was not affected so largely as might be supposed by fluctuations in traffic, one way or the other. As a matter of fact, the company had carried considerably more traffic during the past six months than during the same period of 1892, although the general receipts had been less. The reserve fund was increased, by the interest on investments, to £271,395 10s. 10d. Investments standing in the balance-sheet at a cost of £34,152 13s. 7d., were, at the current market value, about £257,000, or 10 per cent. above cost, which showed that they had been well looked after. The December period, which was only the first half of a financial year, was always much more profitable than the period to June 30th. Notwithstanding this, with a reduced dividend, they were only able to carry forward to the half-year a balance of £3,080; that was without any provision whatever being made for reserve. Looking to the coming year of Atlantic traffic, every provision was being made for taking the traffic in a thoroughly satisfactory way. There are two new cables to be laid down; the Anglo-American Company are to lay one, and the Commercial Company to lay one, so as far as the public service is concerned it will be very efficiently done. The Anglo-American cable probably will be the best laid down in the Atlantic. During the last year, out of the 10 cables working in the Atlantic, there were four down at the present time. The Commercial Company had one down, the Anglo-American Company two, and the Western Union Telegraph Company one. If those cables had been working, and earning, and adding to the pool, probably the Direct Company would not have reason to reduce their dividend with the ½ per cent. They, as directors, thought it wiser to reduce the dividend, and thus strengthen the value of the property. Looking forward to the new cable about to be laid, he was hopeful that they might, perhaps, show a better result in the coming year. He did not want to be too sanguine; he did not like the look of things just now. They had not got through all their commercial troubles, and while they had held their own probably better than any company in existence in London during the hard times, still he did not like the continuance of such times so long, and while they might see some little shade of improvement, yet it would take considerable time for them to get into the old prosperous days. After reviewing the past history of the company, he formally moved the resolution adopting the report.

Mr. E. M. UNDERDOWN, Q.C., seconded, and it was carried unanimously. The usual vote of thanks terminated the proceedings.

Victoria Electric Railway and Lighting Company, Limited.—This company announce the issue of £100,000 5 per cent. debentures of £40 each at the rate of £98 15s. per cent., being a first mortgage absolute on all the property rights, privileges, acquired or to be acquired, during the existence of the bonds which are redeemable by 1932 by the application of a 1 per cent. sinking fund and annual drawings for the first 10 years at £105 per cent., and thereafter at £100 per cent., and payable in London. The prospectus states that the company has for 50 years, from November 21st, 1888, the sole right to organise and work tramways, electric cars, &c., in the city of Victoria, the capital of British Columbia, and its suburbs, to sell electric power for all purposes whatsoever, and to supply electric light to and throughout the city and districts. The earnings for 1893 amounted to $164,000, and the operating expenses to $95,000, leaving $69,000. The loan will absorb $30,000 annually. The company reserves the right to redeem the entire outstanding amount of the bonds at £105 per cent. at any time, on giving six months' notice of such intention. The subscription list closed yesterday afternoon.

Salt Lake and Ogden Gas and Electric Light Company.—The second ordinary general meeting of the shareholders of this company will be held at Winchester House on Saturday, January 27th, 1894, at 12 o'clock, when the board hopes to be able to present accounts and declare a dividend.

Submarine Cables Trust.—On and after February 1st the sum of £1 5s., balance of the coupon due October 15th, 1893, will be paid by Messrs. Glyn, Mills & Co., of 67, Lombard Street, between the hours of 10 a.m. and 2 p.m.

The Chatham, Rochester and District Electric Lighting Company.—Subscriptions are invited for a quantity of 5 per cent. first mortgage debentures.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending January 21st, 1894, amounted to £947; week ending January 22nd, 1893, £973; decrease, £26; total receipts for half-year, 1894, £2,887; corresponding period, 1893, £2,978; decrease, £91.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 19th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £5,530.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.‡	Closing Quotation January 17th.	Closing Quotation, January 24th.	Business done during week ended January 24th, 1894. Highest.	Lowest
184,500*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102	100 —103	102	...
1,134,640*l*	Anglo-American Telegraph, Limited	Stock	43 — 45	43 — 45	44½	43½
2,932,680*l*	Do. do. 6 p. c. Preferred	Stock	81 — 82	79½ - 80½	82½	80½
2,932,680*l*	Do. do. Deferred	Stock	7½ - 8	7½ — 7⅝	7⅝	7⅜
130,000	Brazilian Submarine Telegraph, Limited	10	11½— 11⅝	11½— 11⅝	11½	11½
18,700*l*	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	107 —111	107 —111	108	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅝— 2⅞	2⅝ - 2⅞	2 1/16	2⅝
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2 — 2⅛	2⅛ - 2⅜	2⅛	2⅛
125,000*l*	Do. do. 4½ per cent. Debenture Stock	Stock	104 —106	104 —106	...	...
20,510	Charing Cross & Strand Electricity Supply Nos. 1 to 6, 215 to 718, and 10,001 to 30,000	5	4½— 5	4½ - 5	...	...
44,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	2 — 3	2 — 3	...	...
630,000*l*	City and South London Railway	Stock	28 — 33	28 — 33	...	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	11½— 11⅝	11½— 11⅝	...	...
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	13 — 13½	13 — 13½	13⅜	13⅛
10,000,000$	Commercial Cable, Capital Stock	$100	130 —140	130 —140	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	10/-	1/16— 3/16	1/16— 3/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	4 — 4½	3½ — 4½	...	...
50,000*l*	Do. do. 5 p. c. 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	96 —101	96 —101	...	...
16,000	Cuba Telegraph, Limited	10	11½ — 12½	11½ — 12½	...	...
6,000	Do. do. 10 p. c. Preference	10	18 — 19	18 — 19	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½— 3½	2½— 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	8½— 9½	8½ — 9½	...	...
60,710	Direct United States Cable, Limited, 1877	20	11 — 11¼xd	10⅞— 11 xd	11 3/16	10 13/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	15 — 15¼xd	14⅞— 15¼xd	15¼	14⅞
70,000	Do. 6 p. c. Preference	10	15⅞ — 16¼xd	15⅞— 16¼xd	16⅛	15 15/16
105,900*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 —111	108 —111	...	...
1,294,100*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	114 —117	114 —117	115	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15½ — 15¾xd	15½— 15¾xd	15 11/16	15 9/16
62,700*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	101 —104	101 —104	...	...
222,800*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	101 —104	101 —104	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	115 —118	115 —118	117½	115
108,700*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 —104	101 —104	...	...
146,800*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104	101 —104	102⅜	102¼
300,000*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	103 —106	103 —106	...	...
200,000*l*	Do. 4 p. c. Reg. Mt. Debs. (Mauritius Subsidy) 1 to 8,000	25	106 —109 %	106 —109 %	...	...
120,000	Electric Construction, Limited, Nos. 1 to 120,000	£2	½— 1	½ — 1	⅝	...
12,845	Do. do. 7 p. c. Cum. Pref., Nos. 1 to 12,845	2	1 — 1⅛	1 — 1⅛	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	... ...	... ...	...	...
91,195	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	⅛— ⅜	⅛— ⅜	...	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	0 — ¼	0 — ¼	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	½ - 1½	½ - 1½	...	...
180,227	Globe Telegraph and Trust, Limited	10	8¼ - 8¾xd	8¼ — 8¾xd	8¾	8 9/16
180,042	Do. do. 6 p. c. Preference	10	15½ — 15¾xd	15½—15¾ xd	15⅝	15 5/16
150,000	Great Northern Tel. Company of Copenhagen	10	19⅜ — 20½	20 — 20½	20½	20 7/16
200,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	104 —107	104 —107	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½— 5½	4½— 5½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	6 — 7	6 — 7	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	23 — 24	23½ - 24½	24⅛	23½
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 44	41 — 44	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000 ...	10	1 — 2	1 — 2	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	4½— 4⅝	4½— 4⅝	4⅝	...
15,000	Do. do. fully paid	5	6½ — 6⅝	6⅝— 6⅝	6½	...
37,500	Liverpool Overhead Railway Ordinary, fully paid	10	5 — 5½	4⅞— 5½	5	...
6,295	Do. do. Pref., £6 paid	10	6⅛ — 6¼	8½— 8½	...	...
37,548	London Platino-Brasilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	105 —108	105 —108	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£10 paid)	10	8¼ - 8⅜	8½— 8⅜	8½	8⅜
50,000*l*	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	104 —108	104 —108	...	...
15,000	Monte Video Telephone Co., Ord., Nos. 1 to 15,000 fully paid ...	5	½— 1½	½— 1½	...	...
28,000	Do. do. 6 p. c. Pref., Nos. 1 to 28,000 fully paid	5	2 — 3	2 — 3	...	...
484,597	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜ - 4⅝	4⅜ — 5	4⅞	4⅜
15,000	Do. 6 p. c. Cum., 1st Preference	10	14 — 15	14½ — 15½	14 15/16	14½
15,000	Do. 6. p. c. Cum. 2nd Preference	10	14 — 15	14 — 15	14⅜	14⅜
119,234	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	5¼ - 5½	5¼— 5½	5⅝	5 5/16
726,477*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	112 — 114	112 —114	113¼	112½
48,800	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,452	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	4½— 5½	4½— 5½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	¼— ⅜	¼— ⅜	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 p. c. Guar. Debs., Nos. 1 to 1,000	100	101 —104	101 —104	...	...
11,802	Reuter's Limited	8	5½— 6½	5½— 6½	...	...
19,980	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	6 — 6½	5½— 6½	...	...
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 — 8½	8 — 8½	8½	8½
3,381	Submarine Cables Trust	Cert.	114 —119	114 —119	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	2¼— 2⅜	2¼ - 2⅜	2 9/16	...
37,350	Telegraph Construction and Maintenance, Limited	12	36 — 38	36 — 38	37⅜	37
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	103 —106	103 —106	105½	...
58,000	United River Plate Telephone, Limited	5	1½ - 2	1½ — 2	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 —100	90 —100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	5½— 6½	5½— 6½	...	...
260,900*l*	Do. do. do. 5 p. c. Debentures	100	100 —103	100—103	...	...
30,000	West Coast of America Telegraph, Limited	10	1½ — 2½	2 — 2½	2⅜	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	97 —101	97 —101	...	...
64,242	Western and Brazilian Telegraph, Limited	15	6 — 6½	5⅞ — 6½	5 13/16	...
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	5½— 5⅝	5½— 5⅝	5⅝	...
33,129	Do. do. do. 5 p. c. Deferred	7½	1½— 1⅝	1 — 1½	...	...
178,200*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	104 —107	104 —107	...	...
222,700*l*	Do. 5 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	104 —107	104 —107	...	...
88,321	West India and Panama Telegraph, Limited	10	1 — 1¼	1 — 1¼	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9⅜ — 10¼	9⅜— 10¼	...	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8½ — 9½	8½ - 9½	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	* 100	105 —108	105 —108	106	...
$1,214,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	113 —118	113 —118	...	...
169,000*l*	Do. do. 6 p. c. Sterling Bonds	100	102 —105	102 —105	103	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5¼ — 5⅜	5¼ — 5⅜	5⅜	5 5/16

‡ Unless otherwise stated all shares are fully paid.

† Quotations on Liverpool Stock Exchange.

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Birmingham Electric Supply Company, Ordinary of £5 (fully paid) 5¼—6¼.—Brush Company, 4½ per cent. Debenture Stock, issued at 1 per cent. premium, 106—108.—Electric Construction Corporation 6 per cent. Debentures 87—92.—Electric and General Investment, shares of £5 (£1 paid), 1⅜—2⅜.—Founders' shares, 200—225.—Electricity Supply Corporation, Ordinary of £5, 5—5½.—House to House Company (£5 paid) 1—1½.—Do. 7 per cent. Preference of £5, 5¼—5¾.—Do. 6 per cent. Debentures of £100, 101—103.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 4⅜—5⅛, 1st Preference Cumulative 6 per cent., £5 (fully paid), 6⅛—6⅜.—Liverpool Electric Supply, £5 (fully paid) 6¼—6⅜.—Do. £3 10s. paid, 4¼—4⅜.—London Electric Supply Corporation. £5 Ordinary, ⅞—1⅛.—Manchester, Edison and Swan Company £9 (£1 paid), ⅛—⅜.—Queen Anne's Mansions Lighting and Heating 6 per cent £100 Debentures, 101—103.—Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid) 4⅛—4⅜.

Bank rate of discount, 3 per cent. (October 5th, 1893.

ELECTRICITY IN 1876 AND IN 1893.*

By ELIHU THOMSON.

No similar period in the world's history has in any art shown so rapid development, so extensive and refined scientific study and experiment, so active invention, so varied application, such care and perfection in manufacture, as has taken place in the electrical field within the period since the Centennial Exhibition, 17 years ago.

It can be truly said that, as a department of applied science and engineering, electricity has taken an important place only within the past 10 or 12 years. 17 years ago there were no dynamos in regular operation for electric lighting in the country, although a few machines of the Gramme and Alliance types were used abroad. Special forms of dynamo machines had been designed for electro-metallurgy, and a number of them were in use, but installed only a short time prior to 1876. Small magneto machines had been employed for a number of years previously as substitutes for primary batteries in exploding fuses for blasting and torpedo service. Electric motors, hardly worthy of the name, were here and there operated at great cost from primary batteries, but they were of insignificant power, and resembled the old designs which figured so largely in catalogues and collections of philosophical apparatus—instructive enough in their way, but of no practical value.

What, then, was comprised in such electrical exhibits as were found at the Centennial Exhibition in Philadelphia? There were in the main building a number of such exhibits as telegraphic apparatus and systems of signalling, electric clocks, burglar alarms, and the like. In the class of philosophical instruments were the usual electric models for educational purposes. In Machinery Hall were to be found a few crude electric motors run by expensive and noisome primary batteries. Such motors were of but small power, and belonged to the old types, with electro-magnets and bar armatures successively attracted or repelled. The application of dynamo-electric machines to electro-plating, then in itself quite a novelty, was represented by Weston machines of fair size. In these machines some of the principles of modern self-exciting dynamos were found, but the armatures were of the old-style polar pattern with a single winding terminating in the usual pair of plates called a commutator.

There were, however, two exhibits in Machinery Hall of great interest to electricians as showing types of electrical machinery which in various modified forms were soon to work revolutions in lighting and transmission of power. These two exhibits were of the Gramme and Wallace machines. The Gramme machine itself had become known in the United States through descriptions in scientific journals, and there had been two or three machines imported into the country. A Gramme machine—built, it is believed, at Cornell University—was sent as an exhibit to the Centennial Exhibition. This was probably the first dynamo of the kind built in the United States.

A small belt-driven dynamo was shown, giving current for the working of a single arc lamp in its circuit, series-working being unknown at that time. There was also an arrangement of circuit whereby one machine driven by the belt as a generator furnished current through some 20 or 30 feet of wire to a second similar machine, which then ran as a motor. This was in turn belted to a small centrifugal pump which produced a small cataract of water. Experiments were also made from time to time in the heating and melting of wires by the current generated by the machines on exhibition. Special coarsely-wound low-potential Gramme dynamos for electro-plating were among the interesting features.

The exhibit of Mr. William Wallace was unique in showing a number of different types or forms of dynamo, while the Gramme machines were substantially alike in pattern. The Wallace machines furnished current for single arc lamps, for plating baths, and were reversed and run as motors. This exhibit was very suggestive of types and forms which afterward came into general use, and fortunately the machines themselves were preserved and sent to the World's Fair in the present year, a retrospect, as it were, of the Centennial exhibit. Historically considered, such early models are now invaluable.

The Centennial will be remembered in the history of electrical progress on account of the fact that the telephone of Alexander Graham Bell became then for the first time known as an accomplished fact. With the advent of the speaking telephone there seemed to come about a general awakening to the capabilities of electricity in practical work. Indeed, the telephone had scarcely begun to be used practically before the announcement of the invention of the Jablochkoff candle drew attention to the field of electric lighting, and in 1878 the Avenue and Place de l'Opera, lighted by electric candles, constituted one of the great achievements of the Paris Exposition year. The Jablochkoff candle did not, however, realise expectations; it was too costly, and soon gave place to ordinary arc lamps run in series. Much pioneer work in this field was done in this country by Mr. Charles F. Brush, of Cleveland, who, in in 1879, had as many as 16 arc lamps running in series from one of his well known dynamos.

It was toward the close of 1879 that Thomas A. Edison succeeded in accomplishing the task which he had undertaken, and upon which he had been at work for a year or two. This was the invention of a small electric lamp, giving a light of about the same candle-power as a gas jet, and capable of being run in multiple with many others, without requiring too large a current or too frequent renewals of the lamp.

The great exhibitions held within the period between 1876 and 1893 have embodied more and more electrical arts and productions. Add to these the specially electrical exhibitions—as in Paris (1881), Philadelphia (1884), and Frankfort (1891)—and the growth becomes evidently a gradual unfolding. It was natural, then, not only that the World's Fair of this year should have been characterised by progress in all arts, but that it should have become more distinctively electrical than any preceding international display. It is to be doubted, however, if many were prepared to find that such dependence on the work of the electrical engineer would be shown.

Whether we regard the lighting of the vast areas and spaces in and around the great structures in Jackson Park, or the transportation by rail or water within its boundaries, or the distribution of power for various purposes, it was through the agency of electricity that these objects were attained. In fact, the great bulk of the steam power developed was to give motion to the dynamos for furnishing current for all the various uses to which, in these days, electricity has been applied. It is certainly no exaggeration to say that the vast amount of mechanical power developed and used at the World's Fair was mostly used for electrical purposes or transmitted electrically for its ultimate use. A vast area in the Mechanic Arts building, covered with engines and dynamos driven thereby, directly adjoined the boiler houses, and formed for the time, as it were, the most gigantic electric station ever installed. From it was sent out current for several thousands of arc lights, for from 50,000 to 100,000 incandescent lights, for innumerable electric motors working elevators, driving machinery of all kinds, ventilating, for charging storage batteries, for electric welding, forging, heating, and other uses.

At the Centennial, in 1876, no perceptible fraction of the power was electrically used. At the World's Fair it had become almost wholly electrical. The arrangement of the great Corliss engine at the Centennial was in the middle of the Machinery building, and by a complex system of gears and belts the power was transmitted and delivered to the long lines of shafting extending each way from this central power source. This was a limitation of service arising directly out of the absence of electrical transmission. At the World's Fair, on the other hand, power could be delivered anywhere by the use of electric motors, and the moving machinery was not, therefore, practically restricted to a building in which a steam engine was at hand.

In 1876, arc lights were a curiosity, and but rarely seen. In 1893, their use for illumination of streets and large spaces is almost universal. Never has there been, however, any greater display of arc lighting than in the present year at the World's Fair.

The whole art of lighting by electric incandescence has come into existence since 1876. Incandescent lamps can now be made of such uniformity of voltage and energy

* Abstract from the *Engineering Magazine*.

consumption as even to dispense with any need of photometric measurement, and indeed to require no testing or sorting after manufacture. Such lamps may consume about 3½ watts per candle, and have a useful, economical life of over a thousand hours of service.

The larger part of the incandescent lighting of the World's Fair was carried out on the alternating current plan so commonly employed in cities and towns where the electric station must be at a considerable distance from the mass of consumers.

At the time of the Centennial, alternating currents were known—and dynamos yielding such currents were known, being among the earliest invented—but the transformer was unknown. The nearest approach to it was the induction coil for shocks or medical use, and the Ruhmkorff coil. Soon after the invention of the telephone, however, the induction coil, modified and used in conjunction with carbon transmitters, enormously increased the distance over which speech could be successfully transmitted, and has led in 1893 to the regular communication by telephone over distances more than a thousand miles, while such is the delicacy and fidelity of transmission that it is not necessary to speak much above a whisper at New York or Boston to be heard in the receiver at Chicago.

The transformer or modified induction coil has in like manner rendered possible the economical transmission of electric energy to great distances, as the working of low-voltage incandescent lamps at miles of distance from the supply station. Otherwise the line losses and excessive cost of mains would in such cases forbid the use of direct supply. The perfection to which this useful apparatus, the transformer, has been brought by careful work, may be judged from the fact that it often has an efficiency between 97 and and 98 per cent. at full load. It is a simple affair of copper wire and sheet iron, apparently, but it has required much study and experiment to bring it to the present state of perfection.

In 1876 the storage battery was practically unknown. A crude form, devised by Planté, had been experimented with for a considerable time before, in the laboratory. The eminently successful use made of the electric launches on the lagoons at the World's Fair was an ample demonstration that in the past few years a new field for electrical work had been opened up. The application of the battery to boats is of course but one of the uses for the modern storage cell. Many electric stations in Europe, and a few in the United States, have within late years added an equipment of batteries, to work in conjunction with their dynamos in giving out current energy when the consumption is heavy, and to absorb energy, or become charged from such machines, when the consumption is small. This, in a large measure, prevents overloading at one time, or the running of the machinery with loads too light to be economical at other times. How far experience will confirm the apparent advantage of such a plan remains to be seen.

The largest single exhibit of an electrical nature was, without doubt, the Intramural railway and its power house —together a grand practical exemplification of electricity applied to traction. It was remarkable in many ways as a piece of engineering and operated with the greatest success. It emphasised the fact that the days of steam locomotives on elevated roads in cities are numbered, and that just as surely as the horse car has given place to the trolley car, so must the electric motor supplant steam propulsion on the roads in question. On the Intramural road a conductor rail with the ordinary rails for return circuit was used, the current being taken up by sliding shoes bearing on the conductor rail. The motor car at the head of each train, bsides the ordinary seats, was provided with four electric motors, one geared to each axle individually, while the controlling mechanism was arranged so as to connect the motors in single series for starting, and to make successive changes passing through intermediate connections until the one having all the motors in parallel was reached, the condition for maximum speed.

This arrangement, with refinements of detail especially designed for this work, and first put into full operation at the World's Fair, gave great economy as well as flexibility in the handling of the trains. One of the best illustrations of the progress in the art of electrical engineering in the past few years was the building in the station of the Intramural road of the great direct-coupled continuous current dynamo of 2,000 horse-power capacity. It is a comparatively simple undertaking to design and construct very large alternating current generators, since in many respects they are like duplications or enlargements, simply, of the elements of smaller similar machines. This is not so with continuous current types, as the problems of armature reaction, air gap, and self-induction as affecting the working of the commutator at various loads have to be carefully estimated, while the relation of turns on the armature to number of segments in the commutator, the proper proportions and construction of the commutator itself, and the other proportions, have to be studied with great care and adjusted within limits. The comprehensive exhibit of practical work done in electric welding, included the largest weld ever made by electricity, in which the section at the weld was 48 inches of steel.

In the department of measuring instruments alone, the progress to be noted was remarkable. Ammeters, voltmeters, wattmeters, recording wattmeters, standard resistances, standard cells, electrical balances and bridges, of the highest degree of excellence, were not wanting.

The one discordant note in all this great display of genuine scientific and engineering work was found in the fact that in this same temple of science—in Electricity building itself—naked imposture, quackery in the form of so-called electric belts, hair brushes, insoles, and what not, had obtained a footing and stalked forth unabashed. No words of condemnation can be too strong to be applied to the parasites, who, in the guise of healing and benefaction, succeed in extracting perhaps the last money from the sick and suffering for their worthless trumpery. The fact that such exhibits were found in 1893 holding place alongside of genuine electro-therapeutic appliances of undoubted merit, only heightened by contrast the great shame of their presence.

Our technical schools and universities now devote to the teaching of electricity as a branch of engineering, special courses, special laboratories, special instructors. Formerly, the little electrical knowledge taught was taken up as a department of physics.

In this present year, the arc lamps in use are numbered by the hundred thousand, incandescent lamps by the million, while millions of passengers are carried daily on electric cars, thousands of horse-power transmitted and distributed by electric motors, thousands of tons of metal refined annually by electrolysis, chemical decomposition on the large scale effected, as in the production of cheap aluminium, electric furnaces are turning out their special products, such as carborundum of diamond-like hardness, and electric welding and metal working machines are in active service in a large number of manufactures.

In summing up this great growth, we must not forget the enormous extension of telephone service systems in the past few years. So great have been the advances, that it is natural to expect that in the immediate future similar rapid and important work will be undertaken and accomplished. It is not likely that, except in details, much advance will be made in dynamos and motors. The efficiency of well-designed types is now so high, as to leave very small opportunity for improvement. Large dynamos at full load have commercial efficiencies ranging from 95 to 97 per cent. Transforming apparatus of various types may readily have at full load a net efficiency of 97 per cent. The possible efficiency of arc lamps is about reached, and with the incandescent lamp the volatility of carbon at high temperatures governs the efficiency and life. The higher the temperature the more efficient the lamp, the more volatile the carbon of the filament, and the less will be the life of the lamp. It is unlikely that any better material than carbon will be found for the filament, and the properties of carbon as to volatility can probably not be changed.

The cost of these lamps is now about as low as is consistent with good quality and uniformity. The use of transformers for raising or lowering the line potential permits long-distance transmission of electric energy with moderate loss. The conditions of the most efficient use and operation of electric motors as a source of power when transmitted, have been well worked out, so as to leave but little further to be accomplished in that line.

We can hardly expect, therefore, to make any radical gain in the operation of electric plant unless by the utilisation of new principles in unexplored fields. A substantial gain in

the economy of the development of power from fuel is of much greater moment than any possible gain in the efficiency of the electric plant. Hence electricians are looking for cheaper power, as that, and that alone, now means cheap electricity. For the same reason attention is more than ever concentrated on the utilisation of water-power, as of Niagara itself by the Cataract Construction Company. Much future work will be done in this field, and it will give rise to many new problems for solution by the electrical engineer. It is the fervent hope of many an electrician that, at no very distant time, the energy of fuel may be converted more directly into electric energy, and without the enormous percentage of loss that is involved in present methods, and that some means may be found to further transmute the electric energy into light with but a small percentage of dark heat, instead of present wasteful methods; but this is still a hope only, and there is not even a probable solution indicated.

In the department of electrical engineering work, the early future will, I think, witness, in addition to a constantly increasing use of electricity for illumination, further application to chemical and metallurgical work. The field for the application of electricity to mining, for hoists, for pumping, drilling, mine haulage, and the like, is very wide. While it is not probable that the steam locomotive for long distance railroading will soon be supplanted by electric locomotives, still there is a growing interest in these latter as applicable to special cases, such as specially designed high speed roads between populous centres, for tunnel work, and elevated roads in cities. As feeders for trunk lines of railroad, it would seem that trolley lines are admirably adapted, both for passenger and freight service, and their employment in this way will doubtless become of great importance in densely peopled localities.

There is also a field for the application of electricity stored in batteries to propulsion of road vehicles, a field in which but little has hitherto been done. Electricity generated under present conditions, involving in the first conversion into mechanical power such an enormous loss of heat energy of the fuel, will evidently not be applied as a general heating agent. In certain cases, in which the disadvantage of high cost may be outweighed by superior advantages of application, as in cooking by electric heat, there may result a considerable extension of its usefulness. But that it can be economically applied simply to heat metal bars for forging in a drop-press or rolling machine, is not at all to be expected. In special cases of distinctly local heating of metal for welding, bending, or other process, it is now not only used with success and economy, but it would appear that many additional applications of this kind will be made in the future.

While it may be reasonable to look forward to the ability to telephone through an ocean cable under the Atlantic, it is hardly likely that we shall travel over it in ships propelled by electricity. It would indeed be possible to construct electric motors able to turn screws and propel our largest ships, but the supply of current energy to them at the rate of 10,000 to 20,000 horse-power, for five days continuously, would require a storage battery to be carried such as would be enormously costly, and so heavy that it could not be placed aboard without sinking the ship. It should, however, be borne constantly in mind, in dealing with the subject of electrical applications, that a new discovery might at any time change the aspect of every prophecy based on present knowledge and conditions.

A FEW FACTS ABOUT ELECTRICAL FIRE HAZARDS.

The American insurance agent is a more important individual than his prototype in this country, being invested, as a rule, with greater power and responsibility. He not only seeks business, but has to arrange all necessary details, and furnishes a report of the risk into the bargain. Essentially a man of business, with the commercial instinct strongly developed, he is but little versed in matters scientific. With light and heat in its most ordinary forms he is doubtless well acquainted, and can talk glibly of spontaneous combustion. He is also well up in the manufacturing industries of his district, and where his knowledge fails him, tact and mother wit invariably pull him through.

Without any disparagement of the gentleman in question, it will be easily understood, however, that upon his first meeting with an electric light installation he found himself considerably stuck up. Here was something utterly beyond his ken, and what is of more consequence, something about which he could not well hide his ignorance.

In a recent number of *Cassier's Magazine*, Mr. W. H. Merrill, Jun., of the Fire Underwriters' Association of the North-West, has gallantly come to the agent's aid. Mr. Merrill, in effect, tells him that electricity is but light and heat in another form, and all that is necessary for insurance purposes is to reduce it to the level of a fire stove, and treat it accordingly.

Take, for example, an arc lamp. But let Mr. Merrill speak for himself:—

> Here we have a small spluttering fire used for lighting purposes in insured property. Very well, treat it as such. Put a glass globe around it, and have that globe securely fastened upon a closed base. Don't drape it with ribbons and laces. If inflammable material is near it, have a wire netting around the globe, and a spark arrester, which will close its principal orifice so that it will be impossible for any sparks thrown off by the carbons to escape. Fix it so that the carbons cannot drop out of the lamp. Many fires have been caused from sparks from arc lamps, carbons falling from arc lamps, broken globes not being replaced, and artistic decorations being suspended on or near the lamp. Could not some of these fires have been prevented if insurance men would look at an arc lamp as a small fire, rather than as a wonderful invention whose workings were hard to understand?

It will be admitted, we think, there is a good deal to be said in favour of the eminently practical manner in which the author handles his subject from the fire point of view.

Dealing with other electrical appliances, Mr. Merrill proceeds thus:—

> The most critical defects, from an insurance point of view, in all of them are manifest to anyone who will give the subject a little attention. It needs, of course, more than this to see them all and realise their relative importance; but speaking generally, much can be determined by the layman. The electric motor, with its starting device, the rheostat and its controlling switch, have been responsible for a great number of the more expensive losses. The rheostat is the device used to throw a resistance into the circuit when the motor is started. Call it the throttle for the current, if you please. Now a resistance introduced on the electric circuit transforms electrical energy into heat. Electric heating devices are constructed on this principle; consequently the rheostat is a source of heat. If current is left on the rheostat, it will make a first-rate stove. And yet electrical manufacturing companies design these devices, and sell them enclosed in wooden cases, and instal them so that their coils will come in contact with wood and paper. The building occupant finds that they make good shelves convenient to the motor, and he keeps his oily waste, commutator vaseline, sand paper and odd rubbish on top of them until some one leaves the current on too long, and everything burns up. Would this happen so often if every insurance inspector should look on these things as stoves, and have them treated as such, rather than seeing in them only peculiar devices with peculiar names?

Again smartly handled. Here are all "the facts about the electrical fire hazard" in a nutshell. Still we have somehow a lurking suspicion as to whether our friend, the agent, would know an electric hawk from a magnetic hand-saw. Confronted, for instance, with the elaborate appliances of a modern central station, he might have some difficulty in knowing precisely where the *stove* comes in. However, following Mr. Merrill's lead, he certainly will not err as regards safety if he treats most electrical appliances as possible heat generators of the stove order, and let us hope no one will be rude enough to enquire why and wherefore. Like a certain "eminent electrician," he has no time for details, but goes straight to the "higher flights," and in company, be it said, with many a self-dubbed "electrical engineer"—of the gas and plumber order—we wot of.

A PILLAR OF SCIENCE.*

(*Continued from page* 65.)

The Berlin revolution and the war between Denmark and Prussia interrupted the telegraphic work of Siemens. He was permitted to attempt the defence of Kiel against the

* Personal Recollections of Werner von Siemens. Translated by W. Coupland. London: Asher & Co.

Danes. Such was the respect commanded by the submarine mines laid down by Siemens, that no attack was made on Kiel during the war.

After a period of active service he returned to Berlin to assist the government in constructing a subterranean telegraph line between Berlin and Frankfurt-on-the-Maine, where the German National Assembly was holding its sittings.

During the absence of Siemens on his civil and military duties, Halske continued to make telegraphic apparatus, although no orders were given for instruments. The results, however, justified the foresight and prudence of Siemens's partner.

To return, however, to the suggested telegraph line, it was proposed to lay a rubber insulated wire in a trench without any mechanical protection. This was against the advice of Siemens, who prophesied all sorts of trouble. During the experiments on this line Werner met with electrostatic effects. We cannot dwell here upon the many difficulties which were encountered and overcome during the laying of this line. Werner relates that he had the satisfaction of seeing this long telegraph line not only first in Germany, but in Europe, at work in the winter of 1849. The Prussian Government, at the successful completion of this line, determined to construct other lines. In this year Siemens obtained his discharge from the army, and simultaneously abandoned his post as technical manager of the Prussian State Telegraphs.

With the close of Werner's career as a soldier, we come to the most important part of his scientific labours. He devoted himself, heart and soul, to the scientific problems which practical work had made.

My time on entering the business was entirely claimed by constructive work for the factory, and by the laying down of numerous railway telegraph lines undertaken by my firm. Still, in the winter of 1849-50, I found a period of leisure, which I employed in putting together for publication my experiences on telegraphic communication and apparatus. In April, 1850, I laid my work, with the title "Memoire sur la Télégraphie Electrique," before the Paris Academy of Sciences. This had been rendered possible to me through a lucky accident which enabled me to meet in Paris my friend, Du Bois-Reymond, who intended to present a work of his own to the Academy, and gave me his friendly assistance for the French remodelling of my essay. . . . . The report on my memoir was read by Regnault at a sitting of the Academy. . . . . Leverrier appeared as opposer, and defended the electro-chemical telegraph of Bain, which had likewise been presented to the Academy. The presiding *secrétaire perpétual*, Arago, however, cut short Leverrier's opposition by moving the thanks of the Academy for the memoir, and its reception in the "*savants étrangers*."

There is an occasional expression of bitterness against scientists who have, according to Siemens, not recognised many of his claims to be considered the originator or inventor of processes or apparatus. He considers that through the admission of his memoir into the "*savants étrangers*," and another essay published the same year in Poggendorff's *Annalen*, "On Electrical Lines and Apparatus," which reproduced the entire contents of the memoir so far as they had reference to underground electrical lines, his priority in respect of various scientific and technical achievements has been placed beyond dispute. Nevertheless, unwarranted claims to certain of them were subsequently raised in divers quarters.

This leads me to make here a few remarks on the need of an international literary tribunal, which has in recent times come to be felt with increasing acuteness. It must first of all be granted that in the course of the last decennia, it has become ever more difficult, nay, almost impossible, completely to survey the vast mass of material contained in scientific and technological publications, in many different languages moreover. It is also natural that those who are entirely absorbed in their own special work, but especially those who actively co-operate in furthering the development of the technical application of physical science, find but little leisure to make a thorough study of the doings of others working on the same or on related lines, even if masters of the several languages, and that they in general have also little inclination to turn their attention to the past. As an example of this, I might point to the most highly gifted and inventive physicist of any age, Faraday. He got to know the insulation with pressed gutta-percha only many years after its invention, when it began to be employed in England for submarine cables, the external protection of the insulated conductor being secured by surrounding the latter with iron wires. The surprising phenomena of electrical charges, which Faraday observed in these cables, induced him to publish an essay on the subject. When Du Bois-Reymond, however, sent him, without farther comment, a copy of my memoir presented to the French Academy, Faraday did not lose any time in following up his first work with another, in which he cited the relevant sections of my treatise, and made the declaration that the priority, both of the observation and also of the explanation of the phenomena, belonged to me. Other English writers, as Wheatstone, Jenkin, and many others, have certainly not troubled themselves about either this declaration of Faraday's or any of my other publications.

Nothing would be gained by discussing these allegations against Wheatstone and Jenkin, but there are those living who will consider that injustice has been done to the memory of these men.

The underground telegraphs in Germany caused Siemens great uneasiness, and anxious that he should not be made responsible for any defects that might arise, he wrote a pamphlet which pointed out the existing risks, and made proposals for improvements. This publication led to differences with the Telegraph Department, and all State orders were withdrawn from the firm of Siemens & Halske. This was a severe blow for a young firm; luckily the railway telegraphs formed an independent market for their manufactures, and this quarrel with the State led them to develop foreing business.

Incidentally, we see how the important house of Siemens Bros. came to be established in London. "The excellent progress which the manufacture of telegraphic and other electrical apparatus made in our Berlin factory, suggested the opening of a business connection between William and the firm of Siemens & Halske. He undertook at first to act as an agent for obtaining orders in England, and very cleverly contrived to turn the attention of English technologists to the achievements of the Berlin firm. This was especially furthered by the great Exhibition, which took place in the summer of 1851. Siemens & Halske sent specimens in abundance; their exhibits found universal approval, and procured for the firm the highest distinction—the Council medal."

(To be continued.)

NEW PATENTS—1894.

382. "Improvements in secondary batteries." H. C. L. Holden. Dated January 8th.

426. "Improvements in or relating to wire joints or connections." J. G. A. Kitchen. Dated January 8th.

439. "Improvements in girder clamps and hangers for supporting pipes, electric conductors, and the like." H. H. Lake. (Communicated by C. MacTaggart and F. McKernan, United States.) Dated January 8th.

444. "Improvements in electric light fittings." C. S. Northcote and J. P. Verity. Dated January 9th.

454. "Improvements in the generation and distribution of the electric current." W. Ealdred. Dated January 9th.

455. "Improvements in incandescent lamp shades." E. D. Cooke. Dated January 9th. (*Complete.*)

484. "Improvements in electrical alarum clocks." J. Costigan. Dated January 9th.

489. "Improvements in electrical clocks." E. Herbert. Dated January 9th.

493. "Improvements in safety cut-outs specially applicable for trolley wires of overhead electric railways." A. J. Boult. (Communicated by M. Hanford, United States.) Dated January 9th.

494. "Improvements in forges or furnaces for heating or working metals electrically." W. P. Thompson. (Communicated by C. L. Coffin, United States.) Dated January 9th. (*Complete.*)

495. "Improvements in transformers or converters for electric currents." W. P. Thompson. (Communicated by C. L. Coffin, United States.) Dated January 9th. (*Complete.*)

496. "Improvements in apparatus for heating or welding metals electrically." W. P. Thompson. (Communicated by C. L. Coffin, United States.) Dated January 9th. (*Complete.*)

513. "Improvements in or relating to apparatus for the production and distribution of electricity." G. J. Philpot and R. Hammond. Dated January 9th.

524. "Automatic switch for accumulator charging." R. W. P. Robertson. Dated January 9th.

526. "Improvements in electric brushes." E. L. Levetus. Dated January 10th.

546. "Improvements in electric telephony." A. Muirhead and G. W. Green. Dated January 10th.

548. "Improvements in or appertaining to working quadruplex and duplex telegraph signal receiving instruments." W. P. Thompson. (Communicated by W. F. Melhuish, India.) Dated January 10th.

597. "Fuel economiser and smoke consumer and smoke preventer for steam boilers." R. Sheard. Dated January 11th.

625. "Improvements in or connected with furnaces for consuming smoke and economising fuel." M. M. Milner and J. Thomas. Dated January 11th.

646. "Improvements in primary voltaic batteries." W. Walker, jun., F. R. Wilkins, and J. Lones. Dated January 11th.

649. "Improvements in percussion drills." SIEMENS BROS & Co., LTD. (Communicated by Messrs. Siemens & Halske, Germany.) Dated January 11th.

650. "Improvements in percussion drills and other percussion tools." SIEMENS BROS. & Co., LTD. (Communicated by Messrs. Siemens & Halske, Germany.) Dated January 11th.

653. "Improved means for arranging and intensifying the magnetic fields of dynamo-electric machinery." J. W. T. CADETT. Dated January 11th.

654. "Improvements in electrically illuminated advertising signs." G. C. FRICKER. Dated January 11th.

660. "Improvements in guards for electric and other lamps." J. EATON-SHORE. Dated January 11th.

666. "Improvements in holders for incandescent electric lamps." J. B. C. EVANS. Dated January 11th.

669. "Improvements in electric batteries." C. J. WOLLASTON. Dated January 11th.

679. "Improvements in the manufacture of electrodes and use of the same." A. PHILIP. Dated January 11th.

689. "Improvements in the application of Incandescent lamps for use as night lights." A. W. STEWART. Dated January 12th.

690. "Improvements in electric apparatus for signalling on railways." R. S. HAMPSON. Dated January 12th.

704. "An improved telegraph pole." C. D. BRINDLEY. Dated January 12th.

705. "The improvement of all artificial lights by a more perfect distribution, deflection, and reflection of the light used." R. NUTTALL. Dated January 12th.

722. "Improved electrical marine engine governor." G. L. ADDENBROOKE. (Communicated by R. Macdonald, Australia.) Dated January 12th.

759. "Improvements in the construction of steam turbines." J. S. RAWORTH. Dated January 12th.

764. "Improvements in jointing and connecting electric cables." G. H. NISBETT. Dated January 12th.

791. "A combination door bolt and electric switch." J. J. WILSON. Dated January 13th.

835. "Improvements in the construction of electrolytic apparatus, and in the application thereof in oxidising, chlorinating, and analogous processes." J. HARGREAVES and T. BIRD. Dated January 13th.

836. "Improved means for obtaining metallic bases and their compounds by electrolysis." J. HARGREAVES and T. BIRD. Dated January 13th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1892.

22,285. "An improvement in microphone transmitters." G. L. ANDERS and W. KOTTGEN. Dated December 6th. Consists in the carbon or other points of contact in a vacuum. 2 claims.

22,422. "An improved automatic electrical call apparatus, principally for use in telephone circuits." N. KHEM. Dated December 7th. Relates to a method by which the call bell of any telephone user is, by electric automatic means, always available. 3 claims.

23,750. "An improvement in plates for secondary batteries." A. HOUGH. Dated December 23rd. The inventor coats good conducting wire, preferably copper, with lead, by drawing it through a bath of lead which is not in a fluid condition, but nearly, at its setting point. He draws down the coated wire to a suitable gauge, and forms of it a gauze or network to constitute the frame of a plate. 1 claim.

24,008. "Improvements relating to electric lamps and to apparatus connected therewith." A. L. SHEPARD. Dated December 29th. Claims:—1. An improved electric arc lamp controlled by a combined motor, and relay substantially as and for the purposes specified. 2. In an electric arc lamp a motor, the field magnets of which are wound with fine wire shunted on the arc, and are used for the double purpose, firstly, of providing a magnetic field for the armature; and, secondly, for operating the lever of a relay substantially, as hereinbefore described, and for the purposes specified. 3. The improved electric arc lamp constructed substantially as described.

1893.

78. "Electro-magnets." R. VARLEY, Jun., and F. C. JONES. Dated January 3rd. Consists in using two wires, joined up in series, one a wire covered with insulating material, such as a winding of silk or other fibrous material, or insulated in any other suitable manner, and the other wire a plain or naked wire, and these two are wound side by side, and the layers of coils or helices are insulated from each other by paper or similar material. 4 claims.

140. "Improvements relating to storage batteries and electrodes therefor." G. W. HARRIS. Dated January 3rd. Has for its objects:—1. The construction of a storage battery electrode having large active surface with low internal resistance. 2. The construction of an electrode which shall possess minimum weight and great durability, and 3. To secure the ears or binding posts to the elements of the electrode in such manner as to give increased strength to these parts and afford diminished electrical resistance. 12 claims.

336. "Improvements in or relating to lightning conductors." A. J. BOULT. (A communication from G. Walch, of Bavaria.) Dated January 6th. This improved lightning conductor is mainly characterised by the construction of its intercepting rods, which are hollow and not unlike gas pipes in shape, and which may be readily fitted to the roof. Another novel feature is the shape and arrangement of the point which is to receive the lightning, whereby a larger contact surface between that point and the conducting wire is secured. And lastly, the peculiar arrangement of the connecting sleeves of the conducting wires may be mentioned as part of this invention. 2 claims.

387. "A combined electric launch and sailing vessel." K. D. BOWEN. Dated January 7th. The inventor provides below the water line, or beneath the deck or floor of the launch or vessel, a dynamo-electric machine which gives motion to a screw, or to paddles. The electric driving mechanism is supplied with current from a secondary battery, also below the water line or beneath the deck or floor of the launch or vessel. 1 claim.

471. "Improvements in variable speed electric motors." C. A. ALLISON. (A communication from abroad by C. Hering, of Philadelphia.) Dated January 10th. Claim:—A duplex electric motor consisting of two electric motors, both having the usual parts, namely, an armature and a field, one of which parts is fixed, two of which revolve and are mechanically coupled, and the fourth of which is capable of revolving, and is connected to the work.

517. "Improvements in instruments for measuring electric currents." H. H. LAKE. (Communicated from abroad by E. Weston, of America.) Dated January 10th. Consists, first, devices for dampening or retarding the motion of the index, so that the instrument will be "dead-beat," or substantially so. Second, an arrangement of the scale-plate of the instrument, whereby it may be adjusted in place without disturbing the working parts of the apparatus, and also whereby its indications may be rendered visible in obscure localities. 3 claims.

518. "Improvements in apparatus for measuring electric currents." H. H. LAKE. (Communicated from abroad by E. Weston, of America.) Dated January 10th. Consists in an apparatus for measuring alternating currents of electricity, and in certain improvements thereon, whereby the instrument is rendered independent of the effects of terrestrial magnetism and of temperature variations, and whereby the index may be caused to move over a proportionately increased scale distance for each added increment force. 4 claims.

520. "Improvements in and relating to apparatus for measuring and indicating electric currents." H. H. LAKE. (Communicated from abroad by E. Weston, of America.) Dated January 10th. Consists:—1. In an instrument for measuring differences in electrical potential, and for indicating such differences. 2. In an apparatus which may be used with the said instrument, whereby the latter may be conveniently connected to the line upon which measurement is to be made. 2 claims.

538. "Improvements in electro-magnetically heated receptacles and articles." W. MITCHELL. Dated January 10th. Consists in providing the bottom or body of a receptacle with projecting studs or cores, to which heaters, including wire helices in electric circuit, are applied, the studs, and preferably also the body of the vessel, being of magnetic metal. 7 claims.

724. "Improvements in filaments for incandescent electric lamps." F. R. POPE. Dated January 12th. The inventor immerses raw silk, cotton, or other material in a bath of paraffin, wax, or other hydro-carbon or carbonaceous matter, this being effected either under or without pressure. The material thus treated is then carbonised in the ordinary manner. 1 claim.

1,057. "Improvements in and relating to electric railways." H. H. LAKE. (Communicated from abroad by T. Harris, of America.) Dated January 17th. Primarily consists in the peculiar construction and arrangement of the device whereby the system is equally well adapted to single or double track roads, and, further, in the novel construction and arrangement of the switching devices whereby a single magnet for each section of the working conductor controls the operation of the switching devices in a simple and efficient manner. 5 claims.

1,077. "Improvements in electric telephone apparatus." W. P. THOMPSON. (A communication by C. C. E. Lesenberg, of Germany.) Dated January 17th. Claim:—A switching apparatus for connecting electric telephone places without a central exchange being necessary, characterised by the arrangement that the separate points work with two sources of current common to all the points, which, when two points are connected for conversation, connect the same by two separate circuits into which only the telephone of the one point and the microphone of the other are switched.

1,502. "Improved process and apparatus for the electrolytic production of porous finely subdivided lead for use in secondary batteries." W. P. THOMPSON. (A communication by E. Correns, of Berlin.) Dated January 24th. Lead compounds are mixed in a pulverulent condition with diluted sulphuric acid, sulphates, or even merely with water and a suitable combining material (such as gelatine, glue or the like) and formed into plates of a given thickness. The plates coated with the mixture are then immersed in an electrolytic bath of diluted sulphuric acid or of the sulphates of the alkaline earths, and the plates which cause the conveyance of the electrolytic current placed opposite them. The positive pole of a source of current is then connected with these last-named plates, and the negative pole of the same is connected with the plates holding the above-named mixture. The current is then passed through until all the lead compounds are reduced to lead mud, which will take place in one or more hours, according to the thickness of the layer which is to be converted. 4 claims.